DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. IX. No. 100. APRIL, 1928. 1s. NET.

NO.  100

PRINCIPAL CONTENTS

DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. IX. No. 100. APRIL. 1928. PRICE 1s. NET

Trustees: Sir J. J. Thomson, O.M., F.R.S., Sir F. G. Kenyon, K.C.B., F.B.A., Professor A. C. Seward, Sc.D., F.R.S., Professor R. S. Conway, Litt.D., F.B.A.

Edited by John A. Benn.

Publishers: Benn Brothers, Ltd. All communications respecting editorial matters to be addressed to the Editor; all questions of advertisements and subscriptions to the Manager

Offices: Bouverie House, Fleet Street, London, E.C.4.

Telephone: City 0244 (10 lines).

Telegrams: Benbrolish Fleet.

Annual Subscription, 12*s.* 6*d.* post free anywhere in the world. Single numbers, 1*s.* net; postage 2*d.*

Binding cases for Vol. VIII, 1927, are now ready. Price 2*s.* 6*d.* net each; postage 6*d.*

Editorial Notes.

In publishing this month our Hundredth Number, we may glance back for a moment on the opening eight years of our history. This Popular Journal of Knowledge—to give it its full title—was the outcome of a conference called by the Presidents of the Royal Society and the British Academy, in which the principal learned societies and educational associations were represented, and in January, 1920, the first number made its appearance. Besides description of actual discoveries, some account is given of subjects which do not lend themselves to discoveries as ordinarily understood, but in which new methods and new points of view are being developed. Such were the objects expressed in the first editorial notes, when the magazine was published by Mr. John Murray on matte paper at sixpence. The desirability of half-tone illustrations made it necessary after the first year to print the magazine on art paper as a shilling monthly, a form that was continued when the present publishers took over the journal in 1924.

* * * * *

The founders of *Discovery* intended that all branches of knowledge should be dealt with from time to time, and that its articles should not be limited to science on the one hand or literature on the other. The Trustees, under whose auspices the journal is published, are therefore representative of classics and history as well as of biological and physical science; on another page they contribute their views on this anniversary, each message surveying the position from the particular angle of its writer. Of the numerous discoveries first announced in our columns three will serve to illustrate that the founders' object is being achieved. In the field of ancient studies, Professor Conway's article on tablets revealing a new fragment of Roman history may be recalled. In science, at the time of the first successful demonstration of television in April, 1925, the inventor contributed a description and invited financial support for a discovery which has since become known the world over. In historical research, we have introduced Mr. Ainsworth Mitchell's analyses of documents relating to Mary, Queen of Scots, which have thrown fresh light on the problem of her guilt; a new relic of the Queen's schooldays being the subject of an article this month. Among the congratulatory messages which we print in our Hundredth Number, we value particularly the opinion of Sir Oliver Lodge, whose predictions for the future appear to be well-founded in an issue which, in size at least, is more prosperous than any published hitherto.

* * * * *

The committee appointed last summer by the Secretary of State for Colonial Affairs to formulate a scheme for the creation of an agricultural, scientific, and research service for the Colonial Empire, has now issued its report. The bulk of the document is concerned with detailed proposals for central research stations and methods of staffing, it being recommended that the proposed Service should be divided into two wings, for research and administration respectively. A concluding section deals with the possibilities of agricultural development in the Empire, and points out that the welfare and progress of agriculture is to-day the most vital concern of almost every Colonial Administration. Agriculture, in fact, may be said to be the main industry of the Colonies, and on its efficiency depends, therefore, not only the food supply of the population, but all economic and social progress. Research does not stand still, and any country which lags behind in the application of the latest scientific knowledge to the practice of agriculture may suffer incalculable loss.

Recent figures show the remarkable expansion in Colonial trade which has taken place during the present century. In 1926 the total trade of the Colonies with which we are here concerned, which amounted in 1906 to £157,000,000, had grown to £485,000,000. Rapid and striking as this growth has been, we are as yet only witnessing its infancy. At present the trade of the Colonies depends on the agricultural activities of 50,000,000 people, a number which is small in proportion to the territory they inhabit, and its full development is still to come.

* * * * *

The publication of the "Life of Lord Curzon" has been described as probably the most important biographical event since Morley's "Gladstone," in that all the papers of a distinguished statesman are fully dealt with so near the events. The first forty years of Lord Curzon's life were unusually full, and Lord Ronaldshay devotes the first volume to them. Two other volumes will follow, the second covering the Indian Viceroyalty. In addition to the great series of journeys undertaken between 1883 and 1893, including two voyages round the world and explorations in Central Asia, Persia, the Pamirs, and Afghanistan, the whole of his comparatively brief House of Commons career comes within this period. Apart from these achievements Lord Curzon found time to write three books of outstanding merit on the people and politics of Central Asia, the Far East, and Persia.

* * * * *

Some critics have observed that Lord Curzon's correspondence was excessive and tedious in its detail. Apart from the fact that for the greater part of his life he wrote even official letters with his own hand, refusing the aid of secretaries and the typewriter, it appears that he derived peculiar pleasure from recording his thoughts and impressions. A result of this habit, which does not yet seem to have been remarked upon, may well have been the unusual memory he developed for detailed information—it is, of course, a commonplace that there is no surer aid to memory than the act of writing. Lord Curzon's letters are themselves a memorial to his industry, which, at least in respect of his correspondence, was maintained to the end. We may perhaps recall an undergraduate experience, not hitherto recorded, when Lord Curzon visited Cambridge to make a speech, and was there stricken with his last illness a few hours before the meeting he was to have addressed. The members of a university club of rival political colour who sent him some flowers received immediately a warm acknowledgment, written in pencil from the sickbed.

1920-1928: 100th Issue Messages.

From Sir J. J. Thomson:—

"As I have been prevented by the pressure of other duties from taking more than a merely nominal part in the development of *Discovery*, I am free to express my appreciation of the work of those— the Editors, the Contributors, the Committee, and the Publishers—to whose efforts the success of *Discovery* is due.

"The work has not been easy; there have been strenuous times when the prospect seemed dark and the difficulties depressing. But even in the darkest days the high standard for the articles with which we started was never lowered. These articles have ranged over many departments of knowledge, literature ancient and modern, the physical and biological sciences, archaeology, and anthropology. For my own part I have always found *Discovery* excellent reading and that it widened both one's interests and one's knowledge."

J. J. Thomson

From Sir Frederic Kenyon:—

"As a Trustee of *Discovery*, I respond with pleasure to the suggestion that I should send a word of greeting to its hundredth number. *Discovery* owes its existence, and its survival through a difficult period, mainly to the zeal and vision of Professor Conway. The other Trustees (I think my colleagues would agree) have taken a less active, though not a wholly sleeping, part in its development, but they have from the first represented the lively interest in the project of those concerned in the progress of natural science and of humanism.

"I hope it is gradually establishing its position as the recognized organ of authentic information on the progress of research, told by experts in terms intelligible to the non-specialist. In these days all are alert to hear of new discoveries which advance the borders of human kowledge, whether forward into the mysteries of biology or backwards into the pre-history of our species, or yet further back into the abysses of geological or astronomical

time. All such widenings of our horizon increase our culture and make us more intelligent and therefore more useful citizens. But since we cannot ourselves be experts in all, or perhaps in any, directions, we want our information on these topics to be at once authentic and intelligible; and for such information we are coming more and more to look with confidence to *Discovery*. It fills now a recognized place in our mental equipment. May its hundredth number, with the aid of its sympathetic editor and publisher, be but the opening of an ever-widening career of usefulness."

Frederic G. Kenyon.

From Professor A. C. Seward:—

"The publication of the hundredth number of *Discovery* is an event which affords a legitimate excuse, to those of us who are interested in what we believe to be work for the good of mankind—work it may be that we follow as sympathetic onlookers without doing much to further it by personal service—for proclaiming to the world the fact that the journal has successfully passed through the most critical period in its development, and has reached a stage at which we may confidently prophecy many years of vigorous life. *Discovery* has not only continued to exist; it has been able firmly to establish itself as an efficient part of that complex piece of mechanism with which we may compare the numerous periodicals concerned with the dissemination of knowledge, and let us hope knowledge which in some instances leads us on to wisdom.

"In these days of unavoidable specialization, when those who are trying to advance science publish the results of research in language intelligible only to a small number of experts, it is essential that efforts should be made to present in language which the layman can understand some of the advances in biological science. *Discovery* has played its part in spreading the gospel: it has endeavoured to illustrate by well-chosen examples what biology means; it has shown how in many instances pure science—facts or principles discovered with no ultimate aim other than the search after truth and the interpretation of the mysteries of nature—is the foundation of progress in applied science. It has also, one may add, added to the happiness of many readers by introducing them to the inner courts of knowledge; by providing material which stimulates the imagination and in creating an ambition to contribute by personal observation or experiment to the sum of natural knowledge."

A. C. Seward

From Professor R. S. Conway:—

"In the best farmyards it is understood that however excellent the egg, the cackle of the hen that laid it must be neither too loud nor too long; and those who were concerned with the foundation of *Discovery* must be content to express briefly their pleasure in seeing it reach its hundredth number. As readers of its early volumes know, it sprang from the general desire, particularly manifest at the end of the war, for greater co-operation between the friends of knowledge. Men of very different pursuits joined in the effort to arouse and increase popular interest in research and its results. The value of this central purpose has proved great enough to carry the journal through some vicissitudes of fortune; and it enters on its ninth year with a happy record of service rendered to all sides of knowledge in all parts of the world.

"Taking from Shakespeare our guiding principle of 'looking before and after,' we have done our best to encourage both the studies that relate to the past, of humanity or of the organic and physical world, and the studies that reach out to the future of them all. Not the least of our good fortune has been the liberal sympathies of the two great publishing houses which have supported the venture, and also, if I may be allowed to say so, the valuable and singularly diverse gifts of its successive editors who have vied with one another in the zeal which they have devoted to the work."

R. S. Conway

From Sir Oliver Lodge:—

"*Discovery* is an admirably conducted paper and fills a felt gap. It combines literary and scientific instruction, and must be welcome in many homes. Let me congratulate all concerned in its production on its success and hopeful outlook, and wish it continued usefulness and success."

Oliver Lodge

A New Relic of Mary, Queen of Scots.

By C. Ainsworth Mitchell, M.A., F.I.C.

The discovery of what is probably the earliest writing of Mary, Queen of Scots, suggests that the "Casket Letters" attributed to her at the time of her trial were not genuine, thus supporting previous such evidence.

A FEW months before his death Dr. Walter Seton asked me to co-operate with him in determining

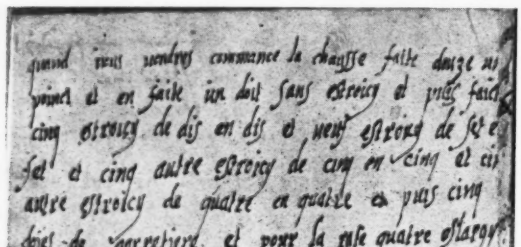


FIG. 1
THE FIRST WRITING IN THE BOOK.
Top of the first fly-leaf at the end of the book, the writing being directions for knitting, a craft at the time introduced into France from Scotland.

whether some writing in an old book was or was not that of Mary, Queen of Scots. As he died before the investigation was complete, I have finished it alone, but even after the preliminary examination Dr. Seton regarded the evidence which I put before him as very convincing.

The book in which the writing occurs is a copy of Polydore Virgil* in Latin, published in 1528, and it is interesting to note that Mary was a good Latin scholar, and that Dr. Seton learned that Polydore Virgil was one of her school books. The writing, which is on two fly-leaves at the end, is not of any intrinsic importance, being merely directions for the knitting of a stocking (Figs. 1 and 2), but it has some subsidiary interest as being probably one of the earliest descriptions of knitting, which, according to the tradition, had only been invented at the beginning of the sixteenth century, and had been introduced into France from Scotland. It would thus have been quite likely that "notre petite Reinette d'Escosse," as her French cousins called her, should have learned a Scottish craft.

It will be remembered that Mary had been sent to France when only six years old, partly to protect her from the schemes of the English, who wished to marry her to Edward VI, but principally that she should be trained by the Queen of France, the notorious Catherine d' Medici, until old enough to marry Francis, the French Dauphin, and so eventually by uniting the two kingdoms to make Scotland a dependency of France.

Dr. Seton attributed this writing to about the year 1555, when Mary would have been thirteen years old, but as it is rather more unformed than her writing of that year, even after making allowance for the fact that her formal letters to her mother, the Queen

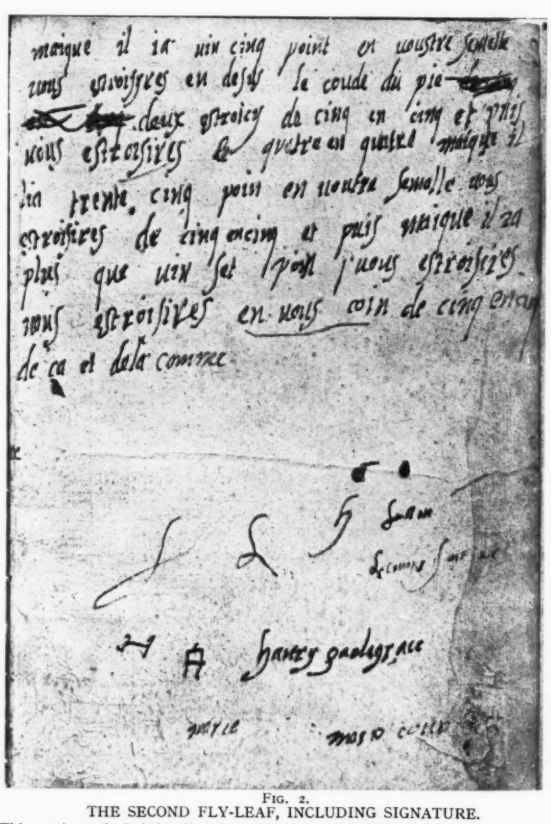


FIG. 2.
THE SECOND FLY-LEAF, INCLUDING SIGNATURE.
This continues the knitting directions, and after some scribbled signs the signature "Marie" is appended. The pen characters are important in comparison with the writing on other documents (see Figs. 3 and 5).

* Polydore Virgil (c. 1470-1555), born at Castro in Etruria. Naturalized in England, 1510, and became Archdeacon of Wells and a Prebendary of St. Paul's Cathedral. Died in Italy about 1555. He wrote a book of proverbs, a book on the origin of all things ("De Inventoribus Rerum, 1499"), and an English history in twenty-six books, first published in 1534.

Regent of Scotland (see Fig. 3), are carefully and neatly written, I should be inclined to put the date a year or two earlier. Some of these early letters may have been written under the supervision of Madame Parois, the mischief-making governess whom Cardinal Lorraine had chosen to mould the views of his niece in the direction of French interests, but others could not have been, for the governess would hardly have allowed complaints about herself to pass (see Fig. 3).

Throughout her life Mary's admitted handwriting shows distinctive characteristics, which it shares with the writing in the book, but for comparing the formation of individual letters in any writing it is necessary to select specimens of approximately the same period. I therefore chose for this purpose a letter written in 1555 (Labanoff, "Lettres de Marie Stuart," Vol. I, pp. 29-32), the original of which forms part of the Balcarres papers in the National Library of Scotland. Among the general characteristics common to the writing in Mary's letters, and to the writing in the book, are the following:—In both the lines follow a wavy course, the letters now rising above the base line, now falling below it. In both may be found a curious increase or decrease in the size of letters in various words; sometimes both increase and decrease occur in the same word. In both there are similar habits for the dotting of the "i's," the dot being sometimes placed to the right, sometimes to the left, sometimes vertical and sometimes omitted. Then there are similar numerical relationships between the different parts of letters. For instance, the cross-stroke of the "t" (not always crossing the upright) are at approximately the same relative heights (which vary in both writings), and the same similarity is to be seen in the cross-stroke of the "f."

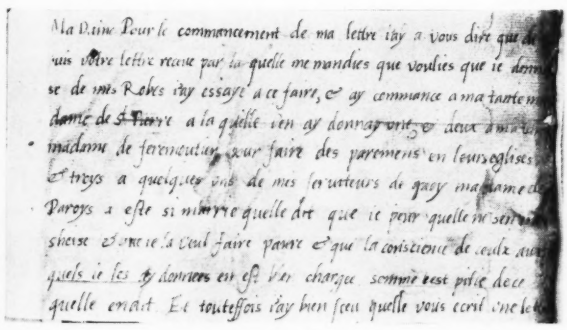


Fig. 3.
MARY'S LETTER TO HER MOTHER, 1555.
In this the young queen complains of her governess Madame Parois. The script aided in the identification of the new writing, shown side by side in Fig. 6.

Fig. 4.
MARY AS A SCHOOLGIRL.
Portrait executed while Mary was in France. (Reproduced by permission from Andrew Lang's "Mystery of Mary Stuart.")

The letter "u" is used in place of "v" throughout the knitting directions, with one possible exception; the same substitution is to be found in several places in the carefully written letters. Similar variations in spelling are common to both writings. Thus "commance" is used in both (reverting later to "commence" in the knitting directions).

Some of the numerous resemblances in the forms of the letters are shown in Figs. 5 and 6. In fact, almost every form of letter in the writing in the book can be matched in the letter. The wording on the second flyleaf in the Polydore Virgil (see Fig. 2) has several points of interest. There are a few childish scrawls, followed by "Hanri par le Grace"—an allusion to Henri II, Mary's future father-in-law. The date is given as "Mai 10," but without the year, and there is apparently the beginning of the word "couvent," followed by the signature "Marie."

Two of Mary's aunts were abbesses of the Order of St. Peter, one at Rheims and the other at Fermoustier, and there is an allusion to them in Mary's letter to her mother (Fig. 3). The writing in the book thus suggests that it may have been written while Mary was staying in the convent of one of these

*

aunts, although, as Agnes Strickland points out, her usual home was in one of the royal palaces.

The signature agrees in its general characteristics with admitted signatures of Mary (Fig. 5), and it is interesting to note that if the succeeding strokes

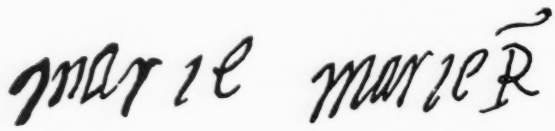


Fig. 5.
MARY'S SIGNATURES.
On the left is an enlargement of that in the book; right, in the letter, now at Hatfield House, written to Queen Elizabeth.

are measured and plotted, as suggested by Fraser and more recently by Locard, as a curve, the shape of this curve agrees closely with that of an undoubted signature of the Queen on a letter written to Queen Elizabeth some thirty years later. This could hardly be a coincidence, especially as the formation and angles of the letters in the two signatures also agree.

The undulations in a line drawn along the bases of the individual letters in the two signatures afford a striking illustration of a characteristic trait of Mary's writing already mentioned. Even the variations in form are suggestive. For instance, the "a" in the signature in the book has the pointed base found in the "a" in "commance" in the letter of 1555, whereas the round "a" in the admitted signature (Fig. 5) is of the type of the "a" in "commance" as written in the book (Fig. 6). These writings of Mary as a young girl have some small evidential value in connection with the notorious "Casket Letters." When the French versions of these letters, produced before the Commissioners appointed by Queen Elizabeth to investigate the charges against Mary, Queen of Scots, were discovered, about 1870, they were subjected to a critical analysis by Lettenhove, who condemned them as forgeries on the ground of the style of the French, the bad grammar, and the bad spelling.

Professor Neale, however, contends (*History*, 1927, 12, 42), that Lettenhove's arguments were destroyed by Bresslau, who (according to Professor Neale) concluded that several of the letters must be genuine, and that the damning letter No. II was "partly genuine." But the facts do not support this contention, for Bresslau, who was a professor at Berlin, while citing numerous passages in common between Mary's admitted letters and the Casket Letters, does not assert that Letter II is partly genuine. His words "zum Theil" refer, not to the letter itself, but to some hypothetical document. What he does say is that Letter II is a forgery "partly based on a genuine foundation," and that since this letter must be rejected, direct proof of the charge against Mary falls to the ground. In controversy an inaccurate translation is a dangerous weapon to use!

As Andrew Lang pointed out, the question of the style of the letters is not a conclusive argument in either direction, since a forger would presumably take care to introduce passages from genuine letters of the Queen into his work. Much more weight must be attached to the evidence of the grammar and spelling. Lettenhove's argument, which Bresslau does

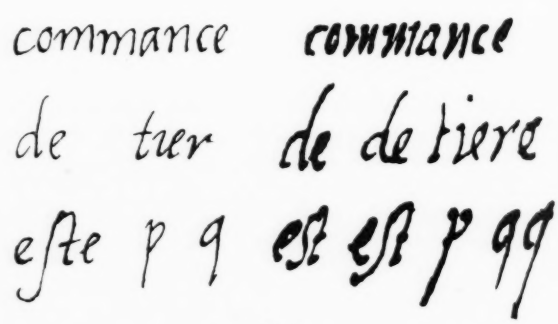


Fig. 6.
PHOTOGRAPHIC ENLARGEMENT OF LETTERS AND WORDS.
(Left.) In Mary's letter to her mother written in 1555. (Right.) From the book.

not even attempt to refute, is that a woman whose mother-tongue was French, who had been educated in France, and who had known intimately the most cultured Frenchmen of the period, would not have fallen into grammatical blunders, such as making *nouvelles* masculine, and *estat* and *amendement* feminine; nor would she have misspelled words, such as *j'envoy*, *contrair*, *sens*, etc., seeing that in her admitted letters she wrote *j'envoie*, *contraire*, *sans*, etc.

It is significant that even as a child of eleven or twelve Mary did not spell *sans* as *sens* (Fig. 1), and thus what is probably her earliest writing extant supplies presumptive evidence that the Casket Letters attributed to her some fourteen years later were not genuine.

BIBLIOGRAPHY.

Bresslau. "Die Kassettenbriefe." 1882.
Lang, Andrew. "The Mystery of Mary Stuart." London.
Lettenhove, Baron Kervyn de. "Bull. de l'Acad. Roy. de Belgique." 1872, 2, 34, No. 17.
Strickland, Agnes. "Lives of the Queens of Scotland." Vol. III. London, 1852.

Saqqara, the Cemetery of Memphis.

By S. R. K. Glanville, M.A.

Department of Egyptian and Assyrian Antiquities, British Museum.

The excavation of Saqqara has afforded details of an ancient cemetery second in size only to that of Thebes. A fascinating chapter in the history of Egyptian architecture is now revealed.

DURING the last five years the Egyptian Government has been carrying out excavations at Saqqara, a dozen miles south of Cairo, which are still in progress under the direction of Mr. Cecil M. Firth, of the Antiquities Service. The time has now come when a general view of the work up to date may be obtained, and some account given of the implications, architectural and historical, that follow from them.

Saqqara comprises several pyramids, a very large number of private tombs of all periods, and the two, much later, Serapeums, on the edge of the high desert west of the Nile opposite Badrashēn, besides a village or two at the foot of the hill. A necropolis second in size only to that of Thebes, barely an hour and a half distant from Cairo, it was until quite recently probably the least visited ancient site in Egypt. The main attraction was the Step Pyramid of King Zoser and the Serapeum, the underground burial place of the sacred Apis Bulls. There was some justification for this comparative neglect. Saqqara is but the cemetery of a mighty city which once spread at its feet as far as the eye could see, but which has now scarcely one block of masonry upon another to mark its greatness. Several years of laborious excavation before the war enabled Sir Flinders Petrie to recover the probable plans of a few of the more important buildings, as well as odd fragments of masonry of various periods, and a number of smaller objects of archaeological interest. But on the whole the results were extremely disappointing, and to-day the only ancient monuments which strike the eye of the traveller crossing from the river to the desert—an hour's ride on a donkey—are two fallen colossal statues of Rameses II and a weathered sphinx. Yet Memphis was undoubtedly the most important city in ancient Egypt; and perhaps it is now no more only because, in a land where successive generations build their houses on the ruins of their fathers', it was to be expected that sooner or later the pitch would become too worn with such constant use. As in other countries, suburbs have become county towns; so, first Fostat and later Cairo became capitals of Egypt, and Memphis faded away to the cultivated land from which it sprang, with only the mud village of Mīt Rahīneh to mark its site.

THE STEP PYRAMID OF ZOSER.

The famous pyramid is here seen from the south-east. The buildings unearthed in the foreground are a series of small chapels which lined the west side of the Jubilee Hall.

There is evidence that there was some sort of town at this spot in predynastic times. It was clearly refounded, probably on an enlarged scale, by one of the First Dynasty kings, perhaps Merpeba. At the beginning of the third dynasty, *c.* 2800 B.C., it became the capital of Egypt. It maintained this position till the end of the Old Kingdom, say for about 500 years, and though suffering mixed fortunes in the First Intermediate period, was second only to Thebes during the Middle Kingdom. With the exception of the period of the eclipse of Egypt during Hyksos' rule, Memphis remained, from that time to its gradual decay under the Byzantine emperors, politically never less than second and from time to time the first city in the kingdom, and commercially the leading centre in North Africa till the rise of Alexandria. The main cause of its continued greatness was its geographical position at the head of the Delta, whence it controlled the navigable waters of the Nile.

The main objective of the excavations at Saqqara during the past few years has been the pyramid area of Zoser, *i.e.*, the famous Step Pyramid and all that lies between it and the *temenos* wall which bounds the "Pyramid estate." It will be convenient to examine the main buildings thus brought to light in the order of their discovery—they happen also to run from north to south—beginning with the pyramid itself.

This tomb of the Pharaoh Zoser was the first, so far as we know, to carry the old *mastaba* tomb of earlier kings a stage forward by increasing the size of the building by the addition of diminishing platforms. The total height of 200 feet thus appears to be made up of great steps, of which there are six; though in reality the additions to the original structure are in a lateral not vertical direction. The new excavations aimed chiefly at clearing the network of passages in the pyramid made by the thieves of later generations in search of the royal builder's treasure. Though interesting to the engineer, they hardly concern us here. What is more important is the discovery of quantities of fine dressed limestone, once the covering of the existing "steps," which are made of the coarse and friable limestone on which the building stands. This finer stone was definitely no more than a covering; and the original pyramid must have displayed much the same stepped form as we see to-day, but with slightly different proportions. The final stage in the evolution of the pyramid-form did not come till the next dynasty, when the steps were made smaller and correspondingly more numerous, and the covering was so cut as to form, when in place, a straight line from top to bottom.

THE ENTRANCE COLONNADE.

View looking east along the magnificent entrance colonnade. The grooved columns are joined two by two, with a narrow strip of wall between each pair.

At the north-east corner of the Step Pyramid two smaller pyramids or enlarged *mastabas* in a somewhat amorphous state of ruin indicated the burial places of royal persons, since they were inside the *temenos* wall. The excavations revealed, against the north wall of each of these *mastabas*, a chapel for the cult of its owner, probably the Princesses Intkaes and Hetephernebti respectively. With these chapels the series of important architectural discoveries begins. The chapel is simply an open court with its back wall against the *mastaba*, and in the centre of that wall a small *cella*, or recess, to receive the food offerings for the dead princess. The workmanship is a very different story. First, the columns set in the back wall are entirely unexpected at this period. It is true that they are only here half-columns, forming an integral part of the wall, but from their use in the entrance colonnade to be described below, it is clear that the principle of the free-standing column was already appreciated—about two hundred years before the period of the Fifth Dynasty temples where it had been supposed that the round column first came into use. And that was still the smooth-surfaced column in direct imitation of the tree-trunk (palm); whereas in the reign of Zoser we are getting the fluted variety, whose discovery it was customary to ascribe to the Middle Kingdom builders of the tombs at Beni Hassan and Assuan, nearly a thousand years later. Secondly, the capitals of these columns are unlike anything found in Egypt or elsewhere. They resemble two long leaves falling from the top, one on either side of the column, and lying close to it.

Though strange to our eyes they are not inelegant, and a rather similar device is to be found on the tops of chair legs in some of the early English work of the last century! Thirdly, where the walls join at the corners a ribbed panel juts out for a short way. This was painted red, the whole panel being probably in imitation of the doubling of the uprights to strengthen the corners of a wooden house.

The next complex of buildings to be unearthed, south-east of the pyramid, was a large courtyard, lined on the side nearer the pyramid with a series of small chapels, each consisting of two narrow chambers parallel with one another and the back wall. The exact nature of these little chapels or, indeed, of the whole of this remarkable building, is not known, though there is evidence to suggest that it was in

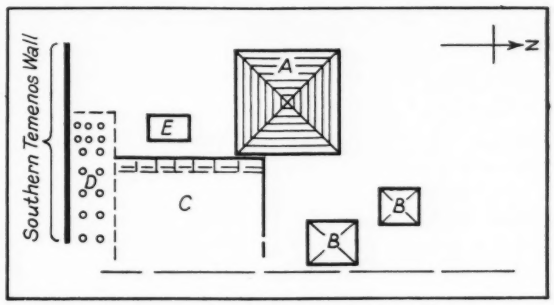
some way connected with the " Hebsed " festival, one of the earliest traditional Egyptian rites at which the king celebrated the anniversary (at one time only the thirtieth) of his accession to the throne. For this reason the building has been provisionally called by its excavators the Jubilee Hall. The fluted columns with double-leaf capitals already described are found occupying a similar position in the back walls of these chapels. But the capital has an interesting addition in the form of a hole between the leaves to carry a copper spout from the flat roof at the back to the front of the column. The purpose of this may have been simply to carry off the water from the roof, but more probably it was to supply to each chapel its own water for use in the cult. Yet more interesting are the dummy doors leading into the chapels, and the partitions separating the individual cells of the chapels from their neighbours to north and south. These doors are of solid stone, but set open—at various angles—and unmovable. They were, in fact, not real doors at all, but dummies. Moreover, they are made to show the circular ends of crossbars in their thicknesses, as if they were of wood. The partitions inside are even more completely in imitation of wooden originals, the upright posts and the crossbars into which these fit being all shown. Thus the main features of these buildings are a direct interpretation in stone of a timber technique.

West of this Jubilee Hall is a small building whose purpose is equally uncertain. Its plan is even more unexplicable, but as it contains no important details save some more dummy doors, we may pass on to the last important building inside the *temenos*.

The Entrance Colonnade.

This is the magnificent entrance colonnade, which runs from the eastern edge of the *temenos* towards the west, just inside the southern *temenos* wall. Here the columns, though still not entirely free-standing, are joined two by two, a narrow strip of wall between each of a pair in order to give strength to the whole construction. But it is impossible not to believe, with the excavator, that this buttressing wall followed and did not precede the conception of the free-standing pillar. It will be seen from the photograph that the pillars themselves in this case are not fluted, but grooved so as to produce in section a series of convex curves, resembling the common imitation of bundles of papyrus or lotus stems in later times.

The next step in the excavations, and the last to be discussed here, is the southern *temenos* wall itself, whose outer face is carried out in a style not found anywhere else in stone. Apart from the imposing



SKETCH PLAN OF RECENT EXCAVATIONS.
A. Step Pyramid. BB. Princesses' Pyramids. C. Jubilee Court. D. Entrance Colonnade. E. Small building with dummy doors, purpose uncertain.

front which it affords to the whole pyramid enclosure, the facing of this wall has a special interest because of its close similarity with the recessed or panelled mud-brick walls of certain earlier buildings at Abydos in Upper Egypt. Nowhere in Egypt do the known brick buildings carry out the idea of the recessed wall in so much detail as in this stone building, and we must go to the Ziggurats of early Mesopotamia for the closest brick parallels. It is, indeed, most probable that the Egyptians learned not only this peculiar brick style of building, but even the very knowledge of brick-making from the early Sumerian inhabitants of Mesopotamia. It is in the thickness of this southern *temenos* wall that an important tomb, whose first rooms have already been opened, is at present being excavated. It would be unwise to discuss the information we have of it as yet, but it is worth noting that the decoration of the first rooms with oblong fayence tiles in two sizes is in imitation of reed mates, the regular wall hanging of houses of that period, and undoubtedly gives us the origin of the border design of the greater part of the later scenes, in tombs on stelae, and even on smaller objects—a design which was borrowed by the Greeks for entablatures, and has come down to us in architecture and on furniture.

An unexpected feature of the work at Saqqara is the discovery that the stone used for all the buildings that have been discussed, except where it was stated to have been of the coarse local variety, is the fine white limestone from the quarries at Tura, a few miles down the Nile from Memphis, on the east bank. The effect of all this fine stone building in the light and soot-free climate of Egypt must have been brilliant, and the labour involved in its cutting and transport from the quarries (not to speak of the actual building) is hardly less startling to contemplate. In the matter of transport a peculiar interest attaches to a small piece of papyrus found in the excavations, on which is written a letter from a senior military officer in charge

of a gang of soldiers on quarry duty at Tura to a high official of the court at Memphis. The letter is about two hundred and fifty years later in date than our buildings. Its burden is that, in the opinion of the writer, the order to send his men to the capital to have new uniforms issued is quite unnecessary; it means the waste of a day, and when he sent them a week before for the same purpose, they were kept hanging about and then sent home empty-handed. The innuendo is that the kit should be sent to *them*. Add the obstruction of official red tape to the mere mechanical difficulties of transporting the stone, and it is clear that the building of Zoser's pyramid was no mean undertaking for his great architect, Imhotep.

Building Technique.

With regard to the implications of these remarkable discoveries, the clear descent of the style of the southern *temenos* wall from the early Sumerian constructions in brick, through Egyptian in the same material, has already been noted. At this time the use of wood and wattle and daub for houses was complementary to that of brick for larger or permanent buildings, and those also we have seen imitated in the fine stone work at Saqqara. Prior to the time of Zoser, the only known instance of building in stone was the flooring of a single First Dynasty tomb. It would appear then that stone building had sprung suddenly into existence in Egypt at an advanced stage! It is recorded, however, on the Palermo Stone that Neneter, a king of the Second Dynasty, built temples in stone. This might mean that the period from Neneter to Zoser, short as it was, brought the new architecture into being and to the remarkable power which we see it had already obtained at Saqqara. But the facts seem to warrant a wider and more probable hypothesis. The art of the architect and the craft of the stonemason may indeed have been developing in the Delta (where any monuments which might prove this have long since been covered in Nile deposit) since predynastic days, while in the south brick remained the only medium for solid building. For Ptah, the patron god of craftsmen, and especially of builders, was a Delta god, whose seat at the White Wall, the predynastic town which later became Memphis, doubtless marked the southern limit of his sway. The origin of this god is unknown, but it is conceivable that he was the craftsmen's counterpart in Syria to the shepherd god Osiris, and that the two came into the Delta together with the people which gave Egypt such a distinctive turn towards the end of the predynastic period. At all events, stone is the natural building material in Syria, and Ptah is certainly to be connected with the knowledge of it as such in Egypt. The facts fit the hypothesis well. The White Wall appears at about the time when this new people has established itself in the Delta. The conquest of the North by the South, resulting in the first united dynasty, produces a series of brick buildings but only one floor of stone, and necessitates the refounding of the White Wall (Memphis) apparently without the use of stone, indicating that this first union was merely political. Its unreality was shown by the rebellion in the Second Dynasty, when, under the rule of a united Egypt by Delta kings, we again hear of buildings in stone (Neneter). The reconquest of the North by the South at the end of the Second Dynasty, and the establishment at the beginning of the Third, of the White Wall as the capital, brings us to the first existing stone monuments—for by this time the two cultures were sufficiently intermingled for the conquerors to adopt the more durable building material of the conquered. But they still cling to the *style* of their old materials—brick, wood, wattle and daub. By the Fourth Dynasty a great deal of that has dropped out, and the stonemasons are working out their own styles in much larger blocks of stone. For the work at Saqqara is characterized by a rather small size of blocks, in marked contrast to the megaliths of the Gizeh sun temple—perhaps another concession to the brick-layers from the south.

Hybrid Architecture.

This remarkable hybrid architecture thus brought into being in Memphis, though logical in its origin, must have required a genius to give it actual expression on such a large scale. Later Egyptian tradition which deified Imhotep as a god of healing, acclaimed him also as the great architect, builder and councillor of Zoser, besides crediting him with a number of the highest offices in church and state. During the excavations at Saqqara the base of a statue of Zoser was found bearing the name of Imhotep. The mention of a private person on a royal statue is unprecedented, and all the more remarkable in this case because the inscription gives Imhotep none of his traditional titles, so that it appears that he was still in the early stages of his career. But it is impossible to doubt that the statue refers to the man who was afterwards deified. It has recently been brilliantly suggested by Dr. Scharff of Berlin that it was at about this time—and not, as is usually stated, in 4241 B.C.—that the calendar was founded, and that Imhotep was its inventor. This agrees very well with his being both the architect and sage of his day.

Cat's Cradles, The World's Most Widespread Game.

By James Hornell, F.L.S., F.R.A.I.

The game of Cat's Cradles is played the world over, and it is not improbable that it afforded a pastime to our ancestors of the Stone and Bronze Ages. A complete record of its occurrence before it becomes obsolete is needed in the interests of ethnographical knowledge.

UNTIL the beginning of this century scarcely anything was known or recorded of the vast variety of games played in many lands with a closed loop of string, the first cousins of the cat's cradle of our own youth, although these are now coming to be recognized as of much importance in ethnological research. Two causes were responsible for this. Writers and observers either considered them in the light of children's trivial play, or, more usually, were actually unaware of their existence among the people they were treating of or studying. It is an extraordinary and yet everyday fact to find that intelligent men who have resided many years in out-of-the-way parts of the earth, and who are credited with intimate knowledge of native customs, are ignorant of the existence among the people of such games, even when these are extremely numerous and highly specialized. Time and again have I found this curious ignorance. For example, when in Samoa a few years ago, I was introduced to an official who had spent many years in the island on terms of great intimacy with the natives, and of whom it was said "he knew *everything* about the customs of the natives." He laughed at the idea of the Samoans playing cat's cradle games and assured me they never did. To make assurance doubly sure, he called into his office an elderly Samoan, who, he said, would certainly know if any such thing existed. The native listened attentively and then concurred with his superior's dictum. A few minutes later, when passing a fisherman's house some hundred yards away, a fishing net attracted my attention. The owner came out and, after answering my questions, invited me within. Sitting with him on the mat floor, I bethought me of my string and began to make an easy figure. My host's face lit up; eagerly lifting the string from my hands, he exclaimed, "I show you Samoa game." And sure enough he did—the first string figure to be recorded from Samoa. From school girls at the Apia convent I learned several more, and it is significant that the Sisters in charge had never before seen the girls playing these games. Similar instances are common elsewhere. Natives show a peculiar and curious reticence in regard to these games, due largely to their fear of ridicule for indulgence in a pastime which they fancy the materialistic white man would be apt to consider childish.

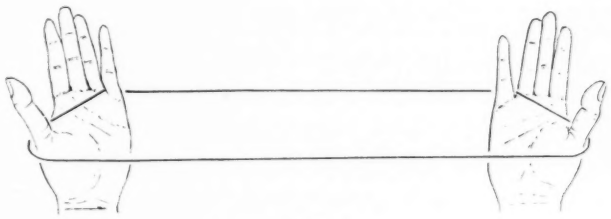


FIG. 1.

CAT'S CRADLE, FIRST POSITION.

Conversely, if the white man is acquainted with some of these games, there is no quicker way to gain the confidence of shy or suspicious natives than to sit down amongst a group of children and amuse them by weaving some pretty or quaint figure with a loop of string. Such a man, they feel, cannot be suspected of guile. A friendly feeling is quickly established, and usually the women and children clamour to have the privilege of showing the stranger some of their own skill in this art of fashioning string figures.

It is comparatively easy to learn to weave many of these patterns, but to record them in words was difficult till Drs. Haddon and Rivers in 1902 published a simple set of technical terms. With the help of these the most intricate games may be recorded clearly and made available for comparative study with those of other localities.

Before putting before the reader a few examples it will be necessary to define concisely such of these terms as have to be employed. Thus a string crossing the palm of the hand is described as *palmar*, that across the back as *dorsal*; a string on the thumb side of any digit is termed the *radial* string, that on the little finger side the *ulnar*. When no confusion can be caused, as when the hands are held upright with the palms facing each other, *near* and *far* may be substituted for radial and ulnar. Three other terms for positions and movements common to many figures are also

conveniently employed. They are the following, viz.:—

Position 1. Place the string around the back of the thumb and of the little finger of each hand in such a way that the part between passes across the palm of the hand (Fig. 1).

Opening A. Assume position 1, then with the back of the index finger of the right hand pick up, from the under side, the left palmar string and return to the original position. Do the same with the index of the left hand; the figure now consists of three loops on each hand—a loop consisting technically of two strings, a radial and an ulnar.

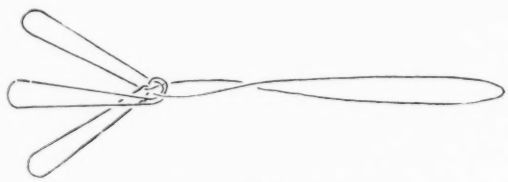


FIG. 2.
BALAWA, THE SCREW-PINE.

Navahoing. Sometimes two loops are found on one of the digits, the higher being the ***distal***, whilst the lower, the one nearer the wrist, is termed the *proximal*. To Navaho, is to lift the lower or proximal loop over the higher or distal one and over the tip of the digit and then to drop it, drawing all strings taut thereafter.

Before discussing the distribution, local characteristics and ethnological significance of string figures, the description of a few representative examples will enable the argument to be followed more easily. Those selected are from the South Sea, where this pastime has reached a surprising degree of development. I premise that at the end of each stage or movement, the hands are to be drawn apart to the original position and the strings tightened. The loop of string used should be from $6\frac{1}{2}$ to 7 feet in length, and the ends neatly joined together; a fairly stout twine is preferable.

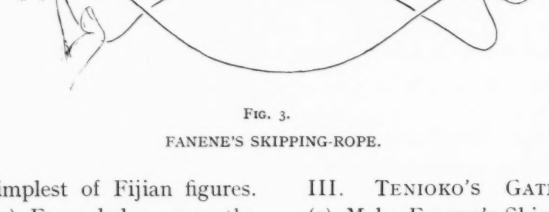


FIG. 3.
FANENE'S SKIPPING-ROPE.

I. BALAWA, THE SCREW-PINE. This is one of the simplest of Fijian figures. (1) Assume position 1. (2) From below pass the right index under the left palmar string and draw this out, giving the loop thus formed a complete twist by rotating the index under it. Return to position. (3) Pass the left index through the loop on the right index and with its back pick up, from below, the right palmar string and return. (4) Drop the thumb and little finger loops of the left hand and draw the hands apart. A three-leaved branch is the result; in New Guinea this figure is called "fish-pear," in Samoa, the "three-toed duck."

II. FANENE'S SKIPPING-ROPE. A very effective and pretty game hailing from Tongatabu in the Tongan archipelago.

(1) Extend the string upon the index fingers. (2) From above take the far string at the middle point between the lips and draw it back. (3) Passing over the right-hand mouth string, catch up the left-hand mouth string on the back of the right index and return to position; similarly catch up on the back of the left index the right-hand mouth string, passing *over* (distal to) the left-hand mouth string in so doing. Release the string held in the mouth. There are now two loops on each index. (4) Pass each thumb over the lower near index string and take upon its back the lower far index string and return. (5) Repeat the movement upon the upper index strings. (6) Bending the middle fingers *over* the upper index radial string, take up on their backs the lower index radial string. (7) Each middle finger is now within a small triangular space. With the lips lift off the string passing across the palmar side of this finger, releasing the string passing around its dorsal aspect, and slip the former string over the tip of the same finger. Repeat three or four times on each hand. (8) Place the thumb from above upon the palmar string of this twisted loop, press down, release the strings on the thumbs and extend.

It will be found that one of the released thumb strings hangs loose and may be thrown backwards and forwards over the stretched figure—Fanene's Skipping-rope.

III. TENIOKO'S GATEWAY.

(1) Make Fanene's Skipping-rope, hanging the loose string pendent on the far side. (2) With the thumbs which press down the palmar strings of the twisted loops, catch up upon their palmar faces the loose strings of skipping-rope, and hold it down together with the companion string. Extend the figure, turning the palms outwards.

The result is a well-defined archway. If desired, the number of loops on the arch may be increased by giving more twists to the middle finger loops when making the Fanene figure.

In many instances long series of figures are made, analogous to those of our own cat's cradle, but much more ingenious and diversified. One of the most effective is the Fijian *Rara-ni-kula* (Parrakeets' Playing-ground) series. The first three figures of this will now be described.

IV. RARA-NI-KULA.

(1) Opening A. (2) Pass the thumb and last three digits of each hand into the index loop of the same hand from the under side, and then by bending all digits outwards, pass the index loops over the back of the hands and down to the wrists. (3) Insert the thumbs into the little finger loops from below and return with the little finger radials on their backs; similarly pick up the thumb ulnars upon the backs of the little fingers. (4) With the thumb and index of the right hand, lift off the double palmar loop from the left hand; slip the left hand downwards out of the wrist loop and with the left thumb and index pass the released wrist loop from the lower side through the free left palmar double loop, now held in the fingers of the right hand; replace the double loop in its original position on the left hand, and place the former wrist loop upon the left index, to form an index loop. Proceed similarly with the double palmar strings and wrist loop of the right hand. (5) Extend, keeping the strings taut and incline the hands towards one another so that the fingers are about 35 degrees from their original position.

The net-like figure produced is the *rara* or green where the Parrakeets love to chatter and preen themselves.

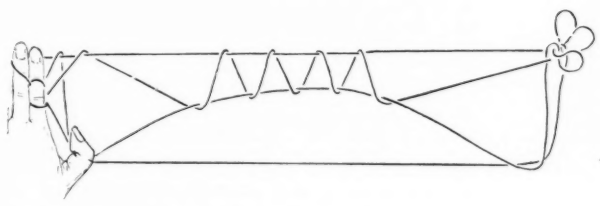


FIG. 4.

TENIOKO'S GATEWAY.

V. VALE-NI-KULA, THE PARRAKEETS' CAGE.

(1) Make the *Rara-ni-kula* figure and straighten the fingers. (2) From below pass the right index under the two palmar strings of the left hand and carry them back to form a double loop on the right index; do the same with the left index and the right palmar strings. (3) Incline the fingers of both hands towards one another and the cage is made.

VI. VONU, THE TURTLE.

(1) Make the *Vale-ni-kula* figure. (2) Navaho the single proximal index loop on each hand over the double and distal loop. (3) Bend the index fingers downwards and hook them over the navahoed single strings that run from back to front of the figure, the right index taking the string on the right, the left index that on the left. Pull these strings outwards with the indices, slipping off at the same time the double index loops. Tauten all the loops as much as possible and equalize the size of the thumb and little finger loops. (4) Slipping all loops to the tips of the respective fingers, lay the figure upon a table, withdrawing the fingers from the loops, as carefully as possible.

A very fair representation of a turtle is the result, the index loops standing for the head and tail respectively, and the double loops for the two pairs of flippers. Two other figures may be made in continuation, but space does not permit of their description.

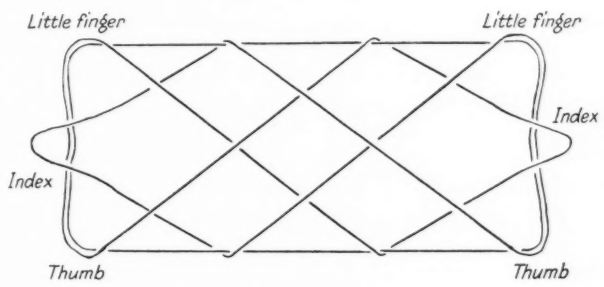


FIG. 5

RARA-NI-KULA, THE PARRAKEETS' PLAYGROUND.

To anyone familiar with the cat's cradle as played in England, two outstanding differences in the working of these South Sea figures will be noticed. In the former the initial position results in two strings crossing the back of each hand in addition to one palmar string, while the co-operation of two players is necessary; in the latter only the palmar string is required, and the moves are made by one person only. These characteristics have been used to distinguish two main divisions, named Asiatic and Oceanic respectively—geographic terms none too happy, for the Oceanic type of game is common throughout the world except in Europe and Asia;

Africans, American Indians and Eskimos have games with typical Oceanic characteristics equally with the islanders of the Pacific.

Although a new branch of ethnological science barely a quarter of a century old, the literature devoted to it is already voluminous, and not a tithe of what it is likely to become a few years hence when the collections now being made in many parts of the world are published. Until then it will not be possible to make full use of the facts already accumulated for the tracing of the relationships and migrations of peoples. For example, till two years ago very few games had been collected from Polynesia, except New Zealand. Since then many blanks have been filled up, and in two recent publications scores of figures from Fiji, the Tongan and Samoan groups, and from the Society and Marquesas Islands, have been recorded; these throw much light on the relationships of the islanders, and give assurance of most valuable results when further work amplifies our knowledge and links up the games of these island groups with those of others of which we know little or nothing at present.

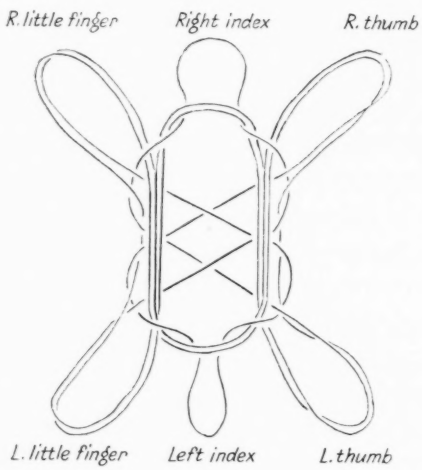


FIG. 6.
VONU, THE TURTLE.

There can be no reasonable doubt that string games had their beginning in the necessity for devising some means of amusement among people so situated as to environment and culture as to have much idle time on their hands. Notably must this cause have operated in the case of the Eskimos, whose string figures are by far the most intricate of any hitherto recorded. A curious peculiarity in their designs is that a large proportion are asymmetric, as, for example, their "Two Ptarmigan," "Dog on a Leash," "Wolverine," and "Fox and the Whale," the last being by far the most involved and difficult figure I have ever come across. Such are much harder to evolve than the bilaterally symmetric patterns almost universal in other regions. It is a safe generalization to say that wherever spinning, weaving and the kindred arts are unknown or little developed, the women and children have resort to this pastime to kill time. Wherever civilization is of old standing, that is, wherever agriculture and the industrial arts are highly advanced, the women folk in general have many more interests in life than their sisters among savage races, and little leisure for unproductive pastimes. Hence we find string figures few and comparatively uninteresting in Europe and Asia, where indeed one game, the original cat's cradle, is alone known to the vast majority of the population. It is by no means improbable, however, that our ancestors of the Stone and Bronze Ages beguiled the tedium of long winter evenings with the working of other string figures, playing doubtless with strings made from the sinews of wild animals, for two or three curious survivals linger on in Scotland and Ireland.

So far as we can judge, the true cat's cradle is of Asiatic—probably Chinese—origin. It seems to have passed westward from China in mediaeval times along the great trade routes to Europe.

In most localities where the Oceanic figures are woven, many are made to the accompaniment of chants, descriptive of the figures represented or of the stories they illustrate. In Polynesia some have mythological references, and it appears as if these were mnemonic aids in the transmission of the stories, like the *quipus* of American Indians. Others again have been pressed into the service of superstition and magic rites, as among certain New Guinea tribes where string figures are made at the yam-planting season and strewn on the ground to ensure that the yams will learn to twine properly. Similarly, some Eskimos weave figures when the sun is going south in the fall, to catch it in the meshes and retard its disappearance. Among another tribe boys may not play these games, for in later life their fingers might become entangled in the harpoon line. Only when they grow up and acquire skill in hunting are they allowed to play. Two hunters who had lost fingers by being nipped in the sealing line were believed to have played the forbidden game when boys. But these are exceptions, and for the vast majority of the figures, their invention has been due to a desire to escape the ennui of long days or evenings with little to occupy the mind or the fingers.

Their intricate designs also furnish the young folk with a delightful amusement that keeps them quiet and out of mischief for hours at a time. In the

outlying villages of many South Seas islands, the children may often be seen carrying loops of string, or ribbons torn from fibrous leaves, hung around their necks, ready to pit their skill against playmates in the weaving of figures.

In former days interest was far greater and more serious, to judge from the character of the chants which often accompany the progress of the game; many are far removed indeed from the jingles that children would invent. For example, in Fiji the women, while weaving the Tambua or Whale-tooth figure, sing the following words in a haunting cadence:—

"My whale's tooth, alas! alas!
Turn it round; alas! alas!
This whale's tooth is not a real one.

Come along and look at it.
Take the whale's tooth string and untie it,
And loosen the small cowry's cord."

And again, when forming the figure of Lulu, the Owl, the words which they chant embody a pretty conceit:—

"The Owl soars on high;
The rat shakes in fear of death
In the long grass."

Space forbids further amplification of this theme, but I trust that what I have written may whet the appetite of many readers to learn more of this subject if only as a pastime and apart from serious study. At the same time I wish to stress the great importance to ethnological progress of the collection before it is too late, of all the figures that survive among indigenous populations—particularly do we require further information from Africa, Madagascar, the hill tribes of India and Indo-China, and from the aborigines of Australia and South America.

New Vitamin Products.

FOLLOWING our report last month of the latest work on Vitamin D, we have received from the British Drug Houses Ltd. some account of their new products which embody this essential food element. Before the discovery that this vitamin could be manufactured from a sterol, it had been generally accepted that vitamins were obtainable only from certain natural sources and in minute variable quantities. Fortunately the British Drug Houses were in a position to adapt this discovery at once to a commercial scale, as ergosterol was already being made in their laboratories. The irradiation was carried out under the supervision of trained technologists, and the therapeutic value of the resulting product (Vitamin D), available under the name Radiostol, is already established. Foodstuffs of every kind are lamentably deficient in Vitamin D, the supply being confined almost entirely to milk and butter, and even these in the winter months contain very little. In consequence an extension of the diet cannot make good the deficiency, and the fact that this vitamin is now available in ample quantities in such standardized products as Radiostol, Radiostoleum, and Radio-malt, is therefore an advance of the utmost importance. Radiostol is issued as a sweetmeat pellet and recommended in the treatment of specific cases of rickets, while Radiostoleum is stated to possess at least twenty times the vitamin content of the finest cod liver oil.

Correspondence.

ELECTRIC HEATING FOR CROPS.

To the Editor of DISCOVERY.

SIR,

I have just been perusing with much interest the article which appeared lately in your columns under the above title, dealing with the electric heating of the soil for market-garden crop purposes. You describe this as a Swedish development. However, your readers may be interested to hear that the practice apparently first originated in Norway, where Hjalmar Olsen is responsible for it. Your article is, of course, correct in that a greater use of this process is being made in Sweden than elsewhere. From the latest reports which I have received, I understand that the demand in the neighbourhood of Stockholm for this purpose is now about five thousand kilowatts. As this heating is switched on by an automatic clock at midnight and off at six a.m., it is a most welcome load from the point of view of electricity generating stations, who are thus enabled to provide the current at a price at which it pays the market gardener to consume it. Incidentally, there was a trifling slip in your quotation of the price, which was stated to be $\frac{1}{4}d.$ per kilowatt: it should, of course, be per kilowatt-hour, or per unit.

It may be of interest to you to know that for a considerable time past I have had a similar installation in my own garden, so that this country can at any rate claim that it is not behind hand in testing the process. The main value of the system is for obtaining early crops, more particularly in the cold months. However, I have got my gardener very enthusiastic and he carried on with this work throughout last spring and the early months of the summer with melons. The result was that he obtained an excellent crop, whilst my neighbours for many miles around were unable to obtain anything of the sort, because of the wet and cold weather.

It seems to me that the gardener and the farmer have a very bad time in their fight against nature. We have experienced trouble this year because, owing to the warmth of the electrically-heated soil, we hatched out slugs which ate the early lettuce. Now we know this, we shall be able to avoid it in future by seeing that earth which is going to be electrically-heated is first sterilized.

Yours truly,

R. BORLASE MATTHEWS.

Greater Felcourt, East Grinstead.

Mosquito Control in Canada.

By Dan McCowan.

Naturalist at Banff, Alberta.

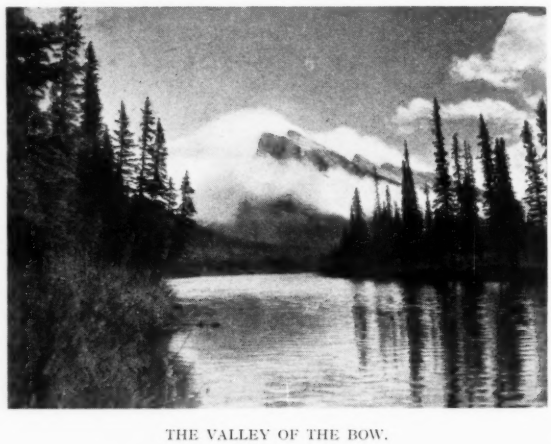
War on the mosquito in a Canadian holiday resort has revealed new details in the insect's life-history. Larvae may hatch from seven-year-old eggs, but it is comforting to learn that the taste for blood is an acquired one.

" Oh, the skeeter he fly high,
Oh, the skeeter he fly low "—

but not in the valley of the Bow, at Banff. For there the National Park authorities have now effectively put an end to the activities of the mosquito, and in so doing have made Canada's premier playground a pleasant tarrying place for the lover of outdoors. To bring about this desirable condition proved no light task. The valley is thickly wooded; there are countless depressions capable of containing snow, flood, and rain water. The entire area selected for treatment comprised some fourteen square miles of incult land, the whole intersected by rivers and brooks, and dotted with a profusion of small lakes. Yet even in such an ideal breeding ground as this, it has been clearly demonstrated that mosquito control is entirely practicable and can be made an unqualified success.

It is, of course, well known that oil is " bad medicine " to mosquito larvae, but experiment showed that special properties are needed. Mosquito larvae are hatched in stagnant water, and on coming to life are obliged to resort frequently to the surface in order to breathe. A thin film of oil spread upon pools and ponds prevents the " wrigglers " from reaching air, and they are thus destroyed. The preliminary tests were made with various kinds of oil. Coal oil and ordinary crude oil, being comparatively inexpensive, found favour at first. In order to function properly, however, it was essential that the oil film remain unbroken for from three to six hours, at the end of which time the entire brood present would invariably be destroyed. But little catspaws of wind and occasional showers of rain easily ruptured and perforated the film of ordinary oil, rendering the operation futile and necessitating the use of much more labour and material. In course of time a special blend of crude oils was obtained, which, while inexpensive, possessed unusual tenacity and was thus eminently adapted for this purpose.

" BAD MEDICINE " FOR THE MOSQUITO.
The oil used to kill the larvae is conveyed in drums to the filling stations of the area under treatment, by means of canoes.



THE VALLEY OF THE BOW.

During the spring and early summer months it was found necessary to give still waters and swampy areas from two to four applications of oil. The fluid was either sprayed from portable tanks similar to those used in fruit spraying, or else simply sprinkled by means of an ordinary watering-can. Metal drums of forty-five gallons capacity were transported in trucks and boats to convenient points throughout the territory, these serving as filling stations for the distribution of oil to the sprinklers. Normally, from one-third to one-half gallon of oil per acre was necessary for each application, the total quantity used being approximately two thousand gallons.

It must not be supposed, however, that the war against these obnoxious insects is entirely waged on the swamps. Highly skilled entomologists, working patiently in laboratories, have devoted much time and thought to mosquito control problems and, incidentally, have brought to light many curious facts concerning the life-history of the mosquito. For instance, it is now known that the life of an adult of the species common to the prairies and boreal regions of Canada may extend over a period of six weeks; that the female lays from eighty to one hundred eggs; that the eggs remain fertile for over seven years, and may possibly be capable of producing larvae at the expiration of a much longer term; that unless the eggs have been frozen, no larvae may be expected from them. It is also interesting to learn that mosquitoes are to be found in the very Far North. Some consolation, too, may be found in learning that normally the mosquito is a vegetarian, and that the taste for blood is a perverted one.

SPRAYING IN PROGRESS.

Is mosquito control an expensive operation? Taking all things into consideration, it is not. The cost of the oil is approximately a shilling per gallon. The work at Banff was carried on by students who are "earning their way" through western universities and colleges, and who made use of their holidays in this fashion. The benefits resulting from the operation are incalculable. Tens of thousands of tourists now annually pass joyous days and restful nights in the greenwood camps of the Canadian Rockies, undisturbed by the shrill pipes and pointed lances of the tormenting mosquito.

The Problem of Abnormal Audibility.

By C. Britton, M.Sc.

Gunfire heard in England during the war was frequently inaudible behind the lines in France. Ten years later research on the problem is still in progress, although a satisfactory explanation is now in sight.

It has been known for some centuries that a very loud sound heard at a great distance from the place of origin may be inaudible at a point nearer the source. Public attention was drawn to this phenomenon during the war. The sound of the gunfire in Flanders was not infrequently heard very clearly on still nights in London, but was not heard at places some twenty or thirty miles behind the firing line.

It was in somewhat similar circumstances, during the wars with the Dutch, that Samuel Pepys noted the phenomenon on the 4th June, 1666. "It is a miraculous thing," he writes, "that we all Friday and Saturday and yesterday did hear everywhere most plainly the guns go off, and yet at Deale and Dover, to last night, they did not hear one word of a fight, nor think they heard one gun." In fact, Governor Strowd of Dover Castle plainly said that the Londoners were mistaken in the sounds altogether and what they had heard was distant thunder. Pepys, however, adds that "it makes room for a great dispute in philosophy, how we should hear it and they not, the same wind that brought it to us being the same that should bring it to them; but so it is." Another interesting early record has recently come to light. The observation was made by Sir Philip Skippon at Wrentham in Suffolk, and he writes under date 7th June, 1673, "An Engagement between ye English and Dutch. Ye noise whereof was heard in Norff. and Lincolnshire, and at Cambridge and Bury. Yet wee about Sowold and Lestoffe could heare nothing, though ye wind was N.E., as favourable to ye Suffolke as to ye Norff. Shore." This "great dispute in philosophy" has remained a dispute until within the last few years, when new discoveries and hypotheses concerning the

physical state of the upper air have suggested a possible solution.

The vehicle of the sound wave is the atmosphere. The vibrations of the sounding body are transmitted to the air, through which they travel until they reach the ear. When they impinge upon the auditory mechanism of the ear we experience a sensation and we say we hear the sound. The farther we go from the source of the sound the less intense the sensation becomes, and finally, when we are far enough away, we fail to hear the sound at all. Theoretically speaking, if there were no loss of energy, the intensity of the sound would decrease inversely as the square of the distance of the observer from the source, but in actual practice, variations in the atmospheric conditions play a very important part in modifying the exact application of this law. It is, nevertheless, true that if we remove ourselves far enough away from the origin of the sound we shall no longer hear it. It seems very surprising, therefore, that if we move, say, twice as far away we may hear the sound again. Yet such apparent anomalies have been observed and studied.

The Silvertown Explosion.

It is, of course, obvious that only a very loud sound stands any chance of being heard at 100 miles from its origin, especially if the listener is not expecting the arrival of the sound. Unfortunately, suitable loud sounds generally occur involuntarily, and there is no opportunity for advising listeners to be on the *qui vive* and to make proper arrangements for making the necessary timing observations. The disastrous explosion at Silvertown during the war gave a sufficiently intense sound wave for the distribution of audibility to be studied. In an irregular area of roughly thirty miles radius around Silvertown the sound of the explosion was audible. This area may be called the region of normal audibility. Around this area was a ring of inaudibility in which no sound was heard. This ring was roughly forty miles wide and included, on its north side, the towns of Ipswich, Cambridge, Oakham, and Uppingham. Beyond this again, we come to an area where the sound was distinctly heard. This zone we may denote as the region of abnormal audibility. In this example, this region extended to a distance of about 120 miles from the site of the explosion, and included the towns of Norwich, Nottingham, and Lincoln.

The explosion in this case was quite accidental, but efforts have been made in recent years to give the subject more detailed study by arranging for the detonation of large quantities of surplus explosive at predetermined instants. A corps of observers were notified of these proposed times of explosion, and they kept careful watch for the advent of the sound wave, noting, if they heard it, the exact instant of its arrival. In this way the areas of silence and abnormal audibility could be mapped out and the times of the passage of the sound studied. A number of such explosions have taken place at Oldebroek in Holland and at La Courtine in France. The results obtained from the three main explosions at La Courtine, which took place on 15th, 23rd and 25th May, 1924, have been collated and discussed by Maurain. In each case similar phenomena were noticed to those disclosed by the examination of the Silvertown explosion. Around La Courtine was a region of normal audibility. Surrounding this area was a zone of silence and outside this, again, one or more areas of abnormal audibility. As a result of these investigations there can be no doubt that the sound of a large explosion can be heard at a great distance, and that the sound wave has not travelled directly over the surface of the earth from source to observer in the normal way. The only feasible explanation seems to be that the sound wave reaches the observer by an overhead route.

In discussing the problem it is necessary to draw attention to an important fact concerning the transmission of sound in air, namely, the dependence of the velocity of propagation upon the temperature of the air. Sound travels faster if the temperature of the air rises, and slower if it falls, the variation being 1.1 feet per second for each degree Fahrenheit. Thus on a cold winter day when the air temperatire is 30° F., the velocity of sound is about 66 feet per second slower than on a hot summer day when the temperature is 90° F. We shall find that this property is of great importance when we come to consider a possible solution of the problem, and it is therefore necessary to consider in some detail what we know of the condition of the atmosphere as regards temperature.

Atmospheric Conditions.

It must be borne in mind that our knowledge of the conditions obtaining in the atmosphere at even moderate heights is a recent acquisition. It has long been known that the temperature of the atmosphere decreased with increasing altitude, and the permanent snow at the summits of high mountains was a visible reminder of this fact. The work of the early balloonists—Gay Lussac, Green, Rush, and Glaisher—confirmed this. Their thermometric observations, carried out to as great a height as their manned balloons would take them, showed that, in general, the temperature continued to fall up to the greatest

altitudes attainable. There appeared to be no reason to doubt that the temperature would continue to fall until in the very upper limits of the atmosphere the degree of cold attained gradually approached the absolute zero. True, a faint suspicion that this might not be the case came in 1862, when Glaisher in an exceptionally high ascent in a balloon found that the rate of fall of temperature with height appeared to decrease near the maximum altitude of the ascent, but this was merely an isolated instance which might be attributed to some irregularity. Unfortunately, a height of 30,000 feet is about the utmost which can be attained in a manned balloon, and if the temperature conditions above this height were to be studied at all, some other way would have to be tried.

Experiments with Balloons.

It was in 1893 that Hermite and Besançon developed the method of releasing small free balloons carrying self-recording instruments. This valuable method has been improved and extended of recent years, and the pioneer work of the late W. H. Dines in this field is well known to meteorologists. These small balloons are often able to attain great heights. The instrument they carry is specially designed to register continuously the changes of temperature and height, and is wonderfully light and compact. Ultimately the balloon bursts or develops a small leak. It descends to the ground with its instrument attached, on which a small label asks the finder to carry out certain instructions. When the instrument is finally returned to the investigator, the record, which is made by fine pens upon a small silvered plate, is deciphered, and tables are drawn up showing the temperatures experienced at various heights. This method of investigation has given satisfactory results in practice, and ascents have been made in many countries under a scheme of international co-operation. As a result of these researches a remarkable fact about the state of the upper air emerged. It was discovered that the temperature of the air did not continuously fall off with increasing height, but that a stage was reached when the temperature ceased to fall and thereafter remained almost stationary. The height at which this remarkable transition occurs has been found to vary with the latitude, with the season of the year, and with the type of pressure distribution prevailing at the time. In general, we may summarize by saying that these researches introduce us to the picture of an atmosphere divided into two well-defined regions. The lower layer is characterized by the fact that, in general, the temperature decreases with the height. The upper layer possesses the characteristic that there is practically no change of temperature in the vertical direction. Teisserenc de Bort coined the term "stratosphere" to denote this newly-discovered upper layer, and the word "troposphere" has been invented for the lower layer. The height at which the transition takes place is called the "tropopause." In these latitudes the height of the tropopause is about seven miles. Over the equator it is higher than this, and over the poles, lower. Thus entry into the stratosphere is likely to be denied to a manned balloon in this country save upon very exceptional occasions.

The question naturally arises, to what altitude does the stratosphere extend. Until the recent investigations of Professor Lindemann and Dr. Dobson, in 1922, there seemed no reason to think otherwise than that it extended to the upper limits of the atmosphere. The greatest heights that had been attained by the free balloons had given no indications of any other marked change in the conditions of the atmosphere, and these researches gave us information up to about fifteen miles and, exceptionally, to over twenty miles. The difficulties in the way of direct investigation are very great, and the attainment of any height greater than twenty-five miles seemed impossible by any known method. Lindemann and Dobson, however, had been studying meteors, or shooting stars, phenomena which take place in the high atmosphere, and as a result of their investigations they were led to some remarkable conclusions as to the physical state of the atmosphere in regions forty miles above the ground. They examined observations of the heights, trajectories,and speeds of several thousands of meteors, and they concluded that the temperature of the air at this great altitude is considerably higher than that prevailing in the stratosphere. They consider that something approaching 100° F. is the temperature in these regions, a figure somewhat higher than the average for the surface.

Sound and Temperature.

This unexpected result leads us to the contemplation of a third atmospheric region occupying a position above the stratosphere, and for which the name "empyrean" has been suggested. F. J. W. Whipple has pointed out that the existence of the empyrean opens the way to a possible explanation of the anomalous audibility of loud sounds at great distances. The basis of this explanation is the refraction which a ray of sound undergoes when passing from air of a certain temperature into air of a different temperature. The analogous phenomenon in the case of a ray of light is common knowledge. When a light ray enters a medium in which the velocity of light is different to

the velocity in air, the ray undergoes bending, or refraction. A ray of light passing from air into water, for instance, is bent sharply away from the surface because the velocity of light in water is slower than in air. The well-known effect of this refraction is to make objects appear to be less deep in a pool than they really are. So in the case of rays of sound. A sound ray in the free atmosphere, however, introduces us to the complication that the air temperature, in the lowest layers at any rate, continuously falls as the ray goes upwards. As an example, let us consider an explosion which takes place at some point on the ground. Sound waves proceed through the air in all directions from the point. Some sound rays proceed horizontally over the surface, others rise nearly vertically, and others rise at intermediate angles. Suppose we confine our attention to a ray of sound which rises from the explosion and is inclined at an angle of, say, 20° with the ground. Now, if the temperature of the air remained constant throughout, then this ray would proceed always in the same straight line and would thus always be at 20° to the ground. But as the temperature of the troposphere is continually falling as the ray goes higher, the ray undergoes refraction and is bent slightly upwards. This upward bending goes on as long as the temperature continues to fall, that is to say, until a height of about seven miles has been attained and the stratosphere has been reached. On meeting these new temperature conditions our ray is now inclined at an angle to the ground which is steeper than the 20° at which it started. What is its experience in the stratosphere? In this region there is practically no temperature change in the vertical direction. This means that there is no further refraction of the sound ray, and it carries on in a straight line throughout the stratosphere.

Maximum Height.

At a height of about 30 miles the ray begins to reach the region of the empyrean and commences to experience temperature changes again. Here, however, the changes are in the reverse direction to those experienced in the lowest layer, the troposphere. The temperature is now increasing with height and the ray is being bent downwards. If circumstances are favourable, this downward bending may continue sufficiently long to enable the ray to enter the stratosphere a second time. If this happens it goes through the original cycle of changes as it passes down through the stratosphere and troposphere, but in the reverse order. If the ray finally reaches the ground we shall have a region of abnormal audibility. The total effect of all the original rays from the sound of the explosion will be to give us, outside the normal audibility zone, a region of silence, because here the rays are passing high overhead. Beyond the zone of silence we shall have the area of abnormal audibility in which the rays have been refracted downwards on to the ground by favourable temperature conditions in the empyrean. It is clear that sufficient sound energy to carry the rays through the long flights required by this explanation can only be obtained from very loud sounds and explosions.

Other Theories.

Other possible explanations of these areas of silence and abnormal audibility may be alluded to briefly. Before the existence of the empyrean was suspected, it was very difficult to explain the facts upon meteorological grounds alone. If we had a wind in the upper air in a reverse direction to that near the ground, such a wind distribution might be adequate to explain the phenomenon, provided the area of abnormal audibility were always to be found to the windward of the explosion. This, however, is not so; the abnormal zone is sometimes to leeward, and in one of the La Courtine explosions this zone formed almost a complete ring. No reasonable theory of wind distribution seems adequate to fit such cases as these.

It has been suggested that the ground may be the vehicle of the sound which is heard in these regions of abnormal audibility. For example, on a night during the war when the gunfire on the western front was very clearly audible upon a chalk hill near London, the sounds were quite inaudible upon a near-by sandstone ridge of equal height. This effect was probably due to atmospheric conditions. The difficulty in assuming the ground to be the vehicle of the sound wave is found in the existence of the zones of silence. This zone is always present when areas of abnormal audibility exist, wherever the explosion itself has taken place, and the presence of these silent zones seems inexplicable on any hypothesis of transmission through the ground.

F. J. W. Whipple has suggested that the sounds due to heavy gunfire might be of sufficient magnitude to enable these areas of abnormal audibility to be detected, and he was successful on one occasion at Grantham in hearing the sounds of a large gun which was being fired at Shoeburyness. Further research is being conducted upon these lines, and it is hoped that the results will cast light upon the acoustic phenomenon itself and upon the state of the high atmosphere. These results will certainly be awaited with great interest.

The Secret of the Cuckoo.

By Oliver G. Pike, F.Z.S.

For some years past the author has been collecting evidence in support of a new theory concerning the habits of the cuckoo. Specific data advanced from observation are illustrated by a remarkable series of photographs.

An enormous amount of controversy has raged round the English cuckoo. Some students say that when the cuckoo deposits her egg in the nest of the fosterer she does it with her beak, while others hold that she always lays her egg into the nest in the normal manner, like any other bird. There are those who compromise and suggest that sometimes she lays her egg, and on other occasions places it there with her beak. A very small minority, who need not be taken seriously, insist that no cuckoo ever has laid direct into a nest.

For about two thousand years past, or as long as we have any record of the cuckoo, the generally accepted theory has been that she first laid her egg upon the ground, picked it up in her beak, and carried it to the selected nest. Mr. Edgar Chance's recent book, "The Cuckoo's Secret," therefore dropped a bomb-shell among nature-lovers, for it proved conclusively that the cuckoos under his observation laid their eggs direct into the nests. Notwithstanding he met with much opposition from those who disliked the old theory upset. Some asked how the cuckoo laid her egg into a fragile nest like that of the reed warbler? Others mentioned instances of cuckoos' eggs being found in the nests of the wren and chiffchaff—two small nests that are domed over with a small entrance at the side, far too small for the cuckoo to enter. A few of the more violent critics said that it would be necessary to photograph every female cuckoo in England if the new theory was to be proved, for some might lay into the nest, while others would carry their eggs to deposit them with their beaks.

CUCKOO IN MEADOW PIPIT'S NEST.

The bird is holding in her beak a pipit's egg previously removed from the nest, into which she proceeds to lay her own egg.

Copyright photograph by O. G. Pike and E. P. Chance.

Following the publication of "The Cuckoo's Secret" I worked in conjunction with the author, and together we produced a cinema film which proved beyond shadow of doubt that the cuckoos which we photographed laid their eggs into the nests, after first stealing one of the original eggs. A wonderful slow-motion film was obtained, which showed every detail of the cuckoo arriving, stealing the egg, and laying her egg in its place, afterwards flying off with the stolen egg which she retained in her beak while laying. A series of conclusive pictures was obtained at five different nests.

Since then others have watched various cuckoos, and some wonderful observations have been obtained. It has been found that whenever the watcher has had a clear view of the whole performance, on each occasion the cuckoo has been seen to lay direct into the nest. Observers have seen her way in the nests of the following birds:—

Tree pipit, meadow pipit, rock pipit, yellow hammer, pied wagtail, and reed warbler. I have seen a cuckoo flying round a hedge-sparrow's nest in which there were two eggs of the owner bird. I had a clear view of the cuckoo as she went to the nest, and there was definitely no egg in her beak. Less than ten seconds later, the nest contained one hedge-sparrow's egg, and one deposited there by the cuckoo. There was no doubt in my mind that she laid it. This rather imposing list contains most of the chief birds that the cuckoo uses as a fosterer, and it goes far to prove Mr. Chance's and my belief, that all cuckoos lay into the nest, and do not deposit the egg with the beak.

Some very careful naturalists have made observations where eggs of the cuckoo have been found in small domed nests. I have watched the cuckoo lay many times; I have been very near the bird on each occasion, and I have come to the conclusion that she would have very little difficulty in laying her egg into these nests by holding on to the sides with her claws, laying the egg into the entrance. It has been noticed that when eggs are found in such nests, the front or sides of each has been disturbed where the cuckoo evidently clung to the exterior. At some of these nests the cuckoo's egg has been found just outside, which goes to prove that when she attempted to lay the egg through the entrance, she failed to do so, and it rolled down and remained outside. If she had been placing it there with her beak and had happened to drop it, she would not have been so foolish as to leave it lying outside, but would have picked it up and made another attempt.

A SEDGE WARBLER AND HER LARGE INFANT.
The ten-day-old cuckoo is already too large for the nest of its foster-parent, whose relative size is here clearly brought out. *Photograph by Oliver Pike.*

On one occasion we surrounded a pipit's nest with thorns and twigs, leaving a little hole at the entrance through which the cuckoo could place her egg with her beak, but we made it so that the bird herself would have extreme difficulty to pass through the entrance. It was interesting to watch what happened when the cuckoo arrived. She first went to the entrance and found it was not possible to pass that way. In front was a flat space on which she could have easily laid her egg, to pick it up afterwards if she so desired. But the bird had no intention of doing this. She wished to deposit her egg in that nest, and the only manner in which she knew how to accomplish this, was to lay it. She examined the gorse bush under which the pipit's nest was concealed, then set about performing her allotted task. She settled on top of the bush, and putting her head down, fought her way through the thorns. She lost several feathers as she went down, but reached the nest. I watched her first take one of the pipit's eggs, then she moved her body on to the nest, laid her egg, and returned the way she came, through the body of the bush.

A cuckoo lays her eggs every alternate day during the laying period. On her laying day, she first takes up her position on a comfortable perch, either a fence, post, or branch. Here she remains very still for a period varying from one to eight hours, and this corresponds to the time spent by other birds which sit on their nests before laying. This discovery alone goes far to prove the modern theory. When she is ready to lay, she leaves her perch and glides to the nest previously located. When she reaches it no time is lost. First she takes out one of the original eggs, quickly moves her body on to the nest, and lays her own egg in its place, the whole performance seldom lasting more than ten seconds. She then flies off with the stolen egg, settles on a convenient perch, throws her head back, and devours the egg. She swallows it rather ravenously, for if she has spent some hours on her perch before laying, this is the first meal tasted for a long time.

When the cuckoo has laid her egg she does not forget all about it. The majority of birds lay a second clutch after their first has been taken. The normal number of eggs laid by a cuckoo would be about five, but if her eggs are taken from the nests of the fosterers, then she continues to lay, and one cuckoo has been known to lay twenty-five eggs in a season. She is not satisfied until she finds that her scattered brood is well on its way to being reared by the various fosterers. When success is assured, she and her mate leave the country.

The story of the young cuckoo is one of the most fascinating in the annals of natural history. The period of the incubation of the cuckoo's egg is thirteen days. When the youngster first hatches out it is blind, and lying at the bottom of the nest it appears as a little lump of almost black flesh. On the first day it takes no notice of its nest companions, or other eggs in the nest, but on the evening of the second, or

HOW THE CUCKOO LAYS HER EGG IN A FOSTERER'S NEST.

A series of photographs enlarged from a cinema film showing a cuckoo arriving at a meadow pipit's nest to lay her egg. (1) The cuckoo arrives. (2) She moves towards the nest. (3) She steals a pipit's egg. (4) Showing the actual moment of laying, with her body over the nest. (5) Commencing to spring from the nest the moment after laying, still holding the stolen egg in her beak. (6) Flying away with the stolen egg. From the moment of approach in No. 1 to the time of flying away in 6 only ten seconds passed.

Copyright photographs by O. G. Pike and E. P. Chance.

the morning of the third day, this helpless looking infant becomes imbued with wonderful strength and instinct. The remaining eggs, or perhaps young in the nest, represent future rivals for food, and this the cuckoo cannot tolerate. So the youngster empties the nest of all other eggs or young. If there are eggs his task is fairly easy for he gets one upon his back, stands up, and rolls each over the side. With young his task is more difficult, but he quickly accomplishes it.

Ejecting a Nest Companion.

I have often tested the strength of young cuckoos with birds very much larger and stronger than themselves. At one nest of the reed warbler that I desired to film, I found that the young cuckoo had forestalled me, and the three young warblers were lying dead under the nest. I found a young sedge warbler in a neighbouring nest, which had feathers on its body, was twice the size of the cuckoo, and was able to see what was taking place. The cuckoo was still blind, but directly I placed the warbler in the nest a most wonderful struggle began. As I watched I could see that it could have but one ending. The cuckoo showed the most amazing powers of strength. It worked down in the nest until its companion was on its back, then, gripping the sides of the nest with its feet, it used the wonderful muscles on its legs and slowly but surely raised its burden. When it appeared to have reached the extent of its stretching powers, it opened the small fleshy arms that would someday be two fine wings, and began to work these up and down. It also jerked its body upwards with violent movements, with the result that the warbler was flung ignominiously over the side of the nest. The youngster now tumbled to the bottom of the nest, worked round to see that there were no more rivals present, then settled down to contentment and rest.

The young bird, now obtaining all the food, grows rapidly. Ten days later it is clothed in fine feathers, and is larger than the nest on which it tries to make itself comfortable. When it begins to fly, the foster-parents follow it about. The youngster will usually sit in fairly prominent positions, and occasionally utters a curious high-pitched note. This seems to have a wonderful effect. Other birds in the district may be carrying food to their own young. If they see the hungry cuckoo sitting there with its great beak wide open, or if they hear that querulous cry, they pause in their flight, and strange to say, hand their supplies to it, and perhaps will even return with further supplies! There was a record a few years ago of a cuckoo that was reared by a pair of hedge-sparrows being fed by five different species of birds.

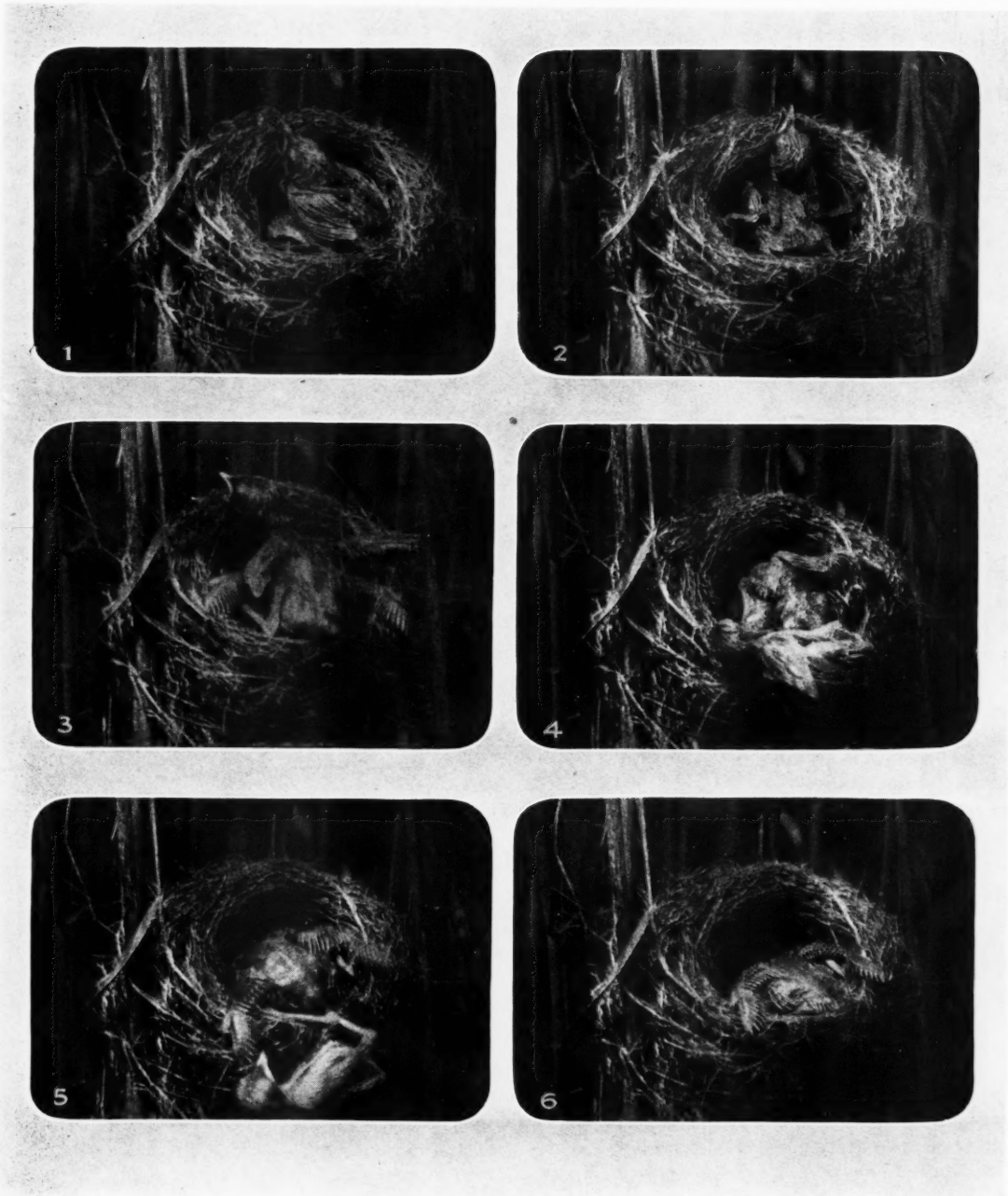
At last the foster-parents leave their great overgrown baby, and then it seems to have some difficulty in finding insect food. While the other birds were bringing supplies, it was content to sit still, but now that it is left to its own resources it has the greatest difficulty in finding similar provisions. It becomes very hungry, and changes its diet to that of a vegetarian, devouring green stuff which it can find in plenty. The crops of twelve young cuckoos, which had been deserted by their foster-parents, were examined, and in each instance no trace of insect food was found. Eventually these youngsters, which are so cleverly able to adapt themselves to their surroundings, find where the insects are hidden, and go back to their usual food. Five, eight, or even ten weeks after their real parents, the adult cuckoos, leave the country, these youngsters launch out on a long journey, flying south, eventually to reach Africa where they spend the chief part of the year.

There is still much to be discovered about this interesting bird, but a word is necessary as regards those observers who say that they have seen cuckoos carrying their eggs in the beak. The cuckoo is a confirmed egg thief, and how do these observers know that the egg that is being carried has been laid by the bird? On her non-laying days I have watched the cuckoo take eggs from other nests, and carry them off, but as far as I know, no one has yet filmed the cuckoo in the act of placing her egg in a nest with her beak.

When we sum up all the evidence we cannot help asking whether the naturalists of the past have not made a great mistake, and been rather prone to follow in the footsteps of predecessors, accepting their statements without taking the trouble to investigate for themselves. In the light of modern discovery, observers of all kinds should start afresh, obliterating from their minds all previous theories. It is only by doing this that we shall be able to steal the cuckoo's secret from her, and prove a much debated problem.

Re-Creation of the Universe.

WHAT is described as an entirely new conception of the universe was announced last month by Dr. Robert A. Millikan, the famous American physicist. According to *The Times* report, the evidence shows tentatively that a building up process is going on to replace the tearing down process represented by radio-activity. New and more precise measurements of the cosmic rays than those hitherto made, show that these rays represent the precise amount of energy which should be emitted in the form of æther waves, when primordial positive and negative electrons unite to create helium and other light atoms such as oxygen.



YOUNG CUCKOO EJECTING ITS NEST COMPANION.

This series of photographs from a cinema film by Oliver Pike shows :—(1) The cuckoo gets underneath. (2) The struggle commences. (3) Having raised its rival, the cuckoo spreads its wings, preventing return to the nest. (4) Over the top. (5) Going. (6) Gone !

The Future of Sheep-Farming in Peru.

Professor Barker's Report.

A remarkable future for millions of undeveloped acres in Peru is predicted by Professor Barker, head of the Textiles Department of the University of Leeds, as a result of recent discoveries in sheep-breeding.

EXPERIENCES in sheep-breeding and wool growing through which Peru is now passing are likely to prove of world-wide importance, according to a report* which Professor A. F. Barker, of the University of Leeds, has prepared for the Peruvian Government. A good start has been made in the development of Peru as one of the great wool-producing countries of the world, and it is quite conceivable that within a decade the wool-clip of Peru may be quadrupled.

Attention was first directed towards the great possibilities of the developments just being inaugurated by Colonel Stordy, under the Peruvian Government, at a meeting held in Perth in 1920—the outcome of propaganda work undertaken by Professor Barker in collaboration with Professor Cossar Ewart of Edinburgh University. Prior to the present century the relationship of the wool-grower to the manufacturer was scarcely developed, the ultimate destination of the wool on the one hand and the breeds and types of sheep on the other being matters of which little or nothing was mutually known.

On arrival in Peru, in 1926, Professor Barker was asked to report to the President not only on the Peruvian Government's experiments at Chuquibambilla, but also to tour some thirty million undeveloped acres in Southern Peru. He was conducted by Colonel Stordy, who has charge of the official experiments and had brought up the subject at the Perth meeting. After landing at Mollendo, Professor Barker was run up to Arequipa in Autocarille and "acclimatized" for several days before ascending to the higher altitudes. In this connexion, it is noted that at 12,000 feet and upwards the altitude appears to affect animals other than sheep—well-bred horses, for example, die off even if acclimatized in stages, whereas pedigree sheep may be taken straight up on the elevated table-lands with no perceptible ill-effect.

FIG. 1.
PHOTOGRAPHING SHEEP AT THE MODEL FARM.

Before proceeding to tour the principal sheep-farming centres, the Professor inspected the Model Farm at Chuquibambilla, where photographs were taken of selected sheep (Fig. 1) which it was thought might throw light on the problems to be investigated. Many of the other remarkable photographs illustrating the report were also taken by Colonel Stordy, of which a few are here reproduced in *Discovery* by permission. The exhaustive nature of the report delayed its publication, but the survey it contains gives many details never previously available.

The prospects of sheep-breeding and wool growing in Peru are strikingly suggested in the survey of the present position with which the report first deals. Earlier statistics are necessarily incomplete, but they are nevertheless very illuminative; it appears, for example, that Peru has doubled its sheep population in a period of about five years.* Apart from the remarkable increase in numbers which the figures indicate, an important deduction concerns the change that has taken place in the weight of the various fleeces; this factor being of first-importance in the genetic aspect of sheep development. If, for example, the results of the experiments at Chuquibambilla should lead to the increasing of the weight of the

	*SHEEP STATISTICS.		WOOL PRODUCTION.	
Approx. dates	1920	1925	1920	1925
Peru	6,357,396	12,600,000	9,000,000	15,432,000
Chili	4,500,000	4,800,000	37,000,000	38,500,000
Argentine	43,000,000	30,267,591	237,000,000	279,392,000

* "The Prospective Development of Peru as a Sheep-breeding and Wool-growing Country." By Professor A. F. Barker, M.Sc., illustrated with photographs by Colonel R. T. Stordy, C.B.E., D.S.O. (Leeds, 1927, English and Spanish Editions, £1 1s.).

Peruvian fleece from 1¼ lb. to 5 lb., Peru with its present flocks would produce from 60,000,000 to 70,000,000 lb. of wool per annum. It would then rank third among the South American wool-producing countries, and could hope soon to rival the output of South Africa.

At present, the weight of the fleece is obviously one of the defects of the Peruvian flocks, and the question will naturally arise as to whether an environment which is naturally producing 1½ lb. of fleece can be constrained to produce, say, a 6 lb. fleece without sacrifice of quality. It is, however, now recognized that in stages Australia increased the average weight of its merino fleeces from approximately 4 lb. between 1825 and 1880 to 6 lb. from 1880 to 1900 and to 10 lb. from 1900 to 1925.

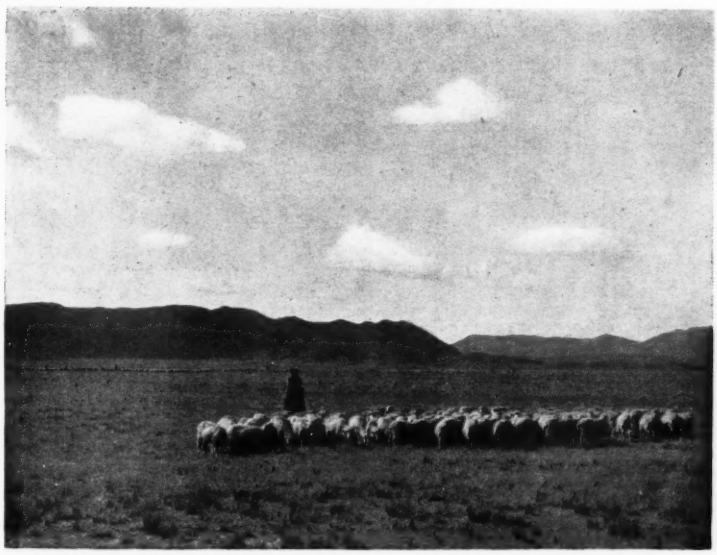


FIG. 2
NATIVE "TENDED" FLOCKS OF SHEEP.
The irregular feeding which native conditions allow has a detrimental effect on the wool, a break in the staple of the wool being attributable to this cause.

It is almost certainly true to say that what Australia has done by cross-breeding and selection, Peru also will be able to do by cross-breeding and careful utilization of its pasture-lands. But present purposes will best be served by candidly recognizing that the Peruvian fleece is exceedingly light, and that this factor must be carefully taken into account in all endeavours to improve and maintain the breed in both weight and quality. Along with the lightness of fleece, however, goes an extraordinarily good yield, the normal loss in scouring the best Peruvian wools often being under 40 per cent, so clean is the pasturage upon which the sheep feed. This excellent yield, along with a special fullness and felting quality, probably explains the liking which some wool-buyers have for native Peruvian wools. In appearance it is sometimes unattractive, but it "works up" much better than is anticipated.

The next section of the report deals in technical detail with the genetic aspects of the study of Peruvian sheep and wool, following which an interesting description is given of the Chuquibambilla Model Farm and of Colonel Stordy's work. As this summarizes the problems with which investigation is at present faced, and shows how they are being overcome, the remainder of our review may be devoted to it. The report, however, contains further sections on sheep-breeding and on the comparative manufacturing values of Peruvian and "improved" Peruvian wools, together with a summary of recommendations based upon the foregoing records. Numerous supplementary data are contained in valuable appendices.

It is pointed out that investigations of the sheep on the heights of the Andes in Southern Peru, and of their extraordinary characters suggests the possibility of introducing better race-characters and of evolving Peruvian sheep on to lines not incomparable with those of Australia and the Cape. This possibility must have been in the minds of the controllers of the destiny of Peru for some time, and it only needed the suggestion of a wool-shortage and dearer wool to bring a scheme for such a development within the range of practical politics. This scheme was formally inaugurated under President Leguia in 1920 when Colonel R. J. Stordy, who had had most useful experiences in East Africa, was appointed with the object of developing a model school upon the Andean heights at Chuquibambilla (12,900 feet). This was to take the lead in experimental work directed towards the evolution of the Peruvian sheep on to lines which would bring "Improved Peruvian Wool" up to the standard required by the European and American manufacturing industries. Some five years of experimentation have been sufficient to define both the possibilities and the lines of development of the

wonderful tract of some 20,000,000 acres of sheep country. Flocks of sheep "tended" by Indian women range without discrimination the tracts of grazing land (Fig. 2), being taken out in the morning and brought to the homestead in the evening—probably just at the time when they would feed the best—with the result that the wool-staple exactly reflects the seasonal feeding possibilities, too luscious at one time and not sufficient at another; this latter condition being represented by almost a disastrous break in the staple of wool. This break may be in part a breed characteristic, but is much more likely to be entirely due to the feeding conditions. Much poorer grazing land to the south of the South American Continent is fenced in, and with the extension of wire mesh fencing, Southern Peru may become one of the richest and best sheep rearing tracts of the world, carrying a sheep upon one to two acres without any fear of an impoverished feed resulting in such a break in the wool-staple.

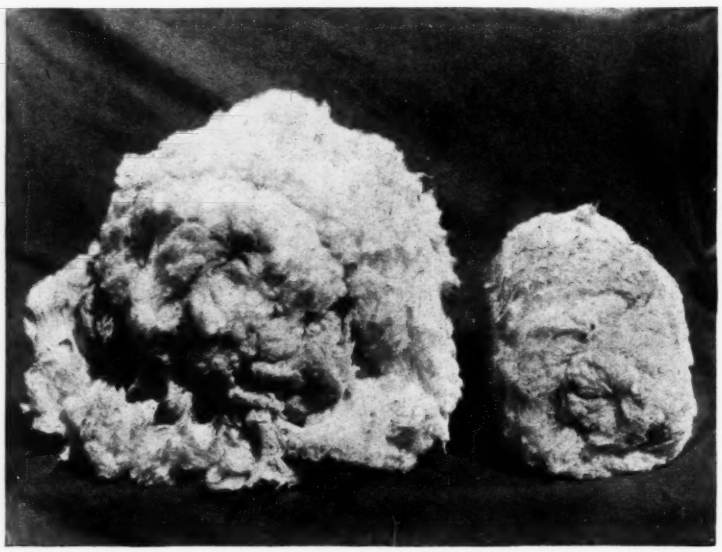


FIG. 3.
NATIVE FLEECE COMPARED WITH IMPROVED FLEECE.
The weight of the half-bred improved fleece is 5 lb. free from kemp, which compares with 1 lb. 6 oz. only of the kempy native fleece.

The rate of the growth of wool has never been clearly defined, but a series of locks sheared from a cross-bred lamb, as recorded in the University of Leeds, tends upon the whole to suggest a regular increase in length of staple. The weight of fleece naturally follows increase in depth of staple and density, and is well illustrated in Fig. 3, in which the native and half-bred improved fleeces are compared, the following being the particulars:—the weight of the half-bred improved fleece is 5 lb. (free from kemp), and that of the native fleece 1 lb. 6 oz. (kempy). The reason for this remarkable increase in weight of fleece is attributable to the larger skin area, to density and length, and to the better distribution of the wool on the body of the half-bred sheep as compared with the native. This is illustrated in Fig. 4. South American and New Zealand buyers of English Romney Marsh sheep have invariably paid the highest prices for the most fully-woolled sheep, and as this characteristic would appear to be entirely a race-character, there is no apparent reason why the well-woolled body should not be maintained in the Improved Peruvian flocks.

The improved shearing and getting-up of the wool naturally follow Colonel Stordy's organization and training of the Indians upon the farm. When inspected at work on the farmstead these men were found to be shearing well—the sheep do not present the "bloody mess" so frequently to be seen on Australian stations, as no attempt is made to shear into the hundreds a day.

With these actualities fully in view it is not surprising that Peru should feel strongly encouraged to go forward with this development. What it may ultimately mean will be realized if the present and prospective conditions of the Indian upon the heights be considered. At present these people—descendants from the inhabitants of the Inca Empire—live entirely a "self-contained" life. They build their huts of adobe bricks; plant their patches of sweet-potato; tend their sheep, shear the wool, spin the yarn, and weave the cloth for their garments (as is described in an interesting section of the report on Peruvian native industries). They neither desire to sell nor to buy anything. But the sheep only yield, say, 1¼ lb. of wool. Colonel Stordy's experiments show that if well-bred rams—or even half-bred rams—are introduced the fleece weight will be increased to from 3 to 5 lb. The Indians will then have wool to sell and money to spend, with effects on the conditions in Peru that can readily be imagined.

The quality of wool already produced suggests that the "Improved Peruvian Wool," when stabilized and produced in sufficient quantity, may well challenge comparison with the wools from Australasia and the Cape as sold at the London Wool Sales. Although wool will always be dominant, yet the way in which Down sheep thrive at the Model Farm suggests that a good type and weight of carcase may be produced, and as the farm is close to the railway which leads direct to the port of Mollendo, a frozen meat traffic between Peru and Europe might readily be inaugurated. Merino mutton is notoriously good but lean; several of the suggested crosses should give an ideal carcase sheep.

It is obvious that a careful survey of all possible breeding types and conditions is at this juncture most desirable, for if the right type of "cross" is adopted and developed upon the right lines, and if a sufficiently large quantity of the Improved Peruvian wool be placed upon the market, so far as can be humanly foreseen success, and probably very marked success, must inevitably follow.

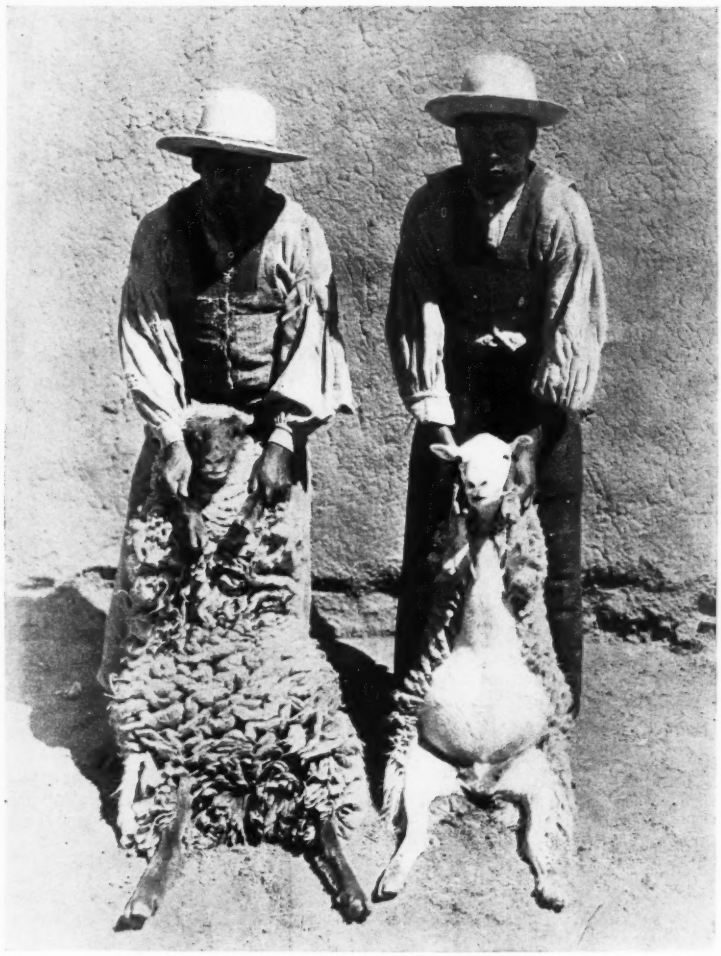


FIG. 4.
NATIVE SHEEP COMPARED WITH IMPROVED SHEEP.
The larger skin area of the half-bred sheep and the better distribution of the wool on the body, accounts for the remarkable increase in the weight of fleece as compared with the native.

Professor Barker concludes by stating the two objects which were held in view in writing his report: the first, to give that encouragement to Peru in sheep-breeding and wool-growing which is already so well merited; the second, to present the bewildering array of facts recorded, and to be daringly speculative with the object of revealing the extraordinary scope for research with reference to genetics and heredity which the fields covered present.

To illustrate the possibilities resulting from the collaboration of the industrialist, the technologist, and the scientist, reference is made to a case in which the President of the British Wool Federation (Mr. W. Hunter) started the research by stating that Native Peruvian wools were specially useful owing to their milling qualities. As a technologist it was natural that Professor Barker should decide to follow this up by actual experiments with Native and Improved wools, with the result that data on relative felting properties were obtained; and knowing that the rates of milling might be important, he asked Mr. J. B. Speakman, lecturer in physical chemistry in his department, to work out these further particulars. In doing this it occurred to Mr. Speakman that the curves obtained could be analysed into their component factors, and in attempting this he has made discoveries of dominating importance with reference to the milling of wools. These discoveries form a notable addition to the science of the textile industries.

Among the Stars: A Monthly Commentary.

By A. C. D. Crommelin, D.Sc., F.R.A.S.

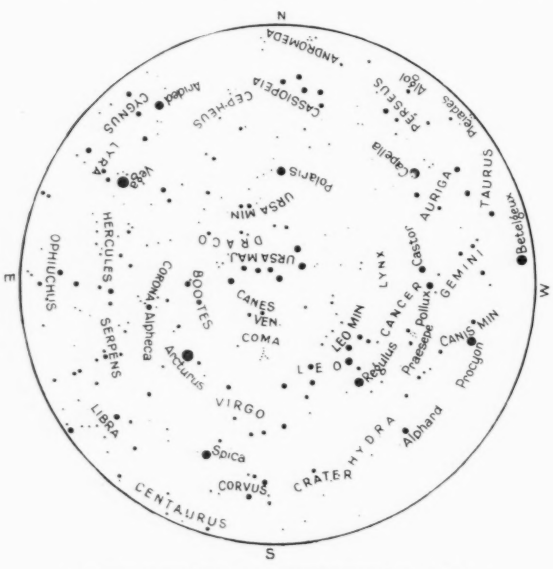
THE FACE OF THE SKY FOR APRIL.

THE southern constellations of the Zodiac, Libra and Scorpio are now coming into view. It should be noted that the times given for the star-map are not in summer-time, but in the old reckoning. This is more convenient than summer-time for all astronomical purposes. Jupiter and Uranus pass conjunction with the sun, and are invisible; but Saturn is approaching opposition, and may be seen after midnight. A small portion of Centaurus is visible on the southern horizon; this constellation contains our nearest stellar neighbour, but this is too far south for us to see.

Two occultations of fairly bright stars may be observed; on the 24th epsilon Geminorum disappears at 10.3 p.m. and reappears at 10.35; on the 25th kappa Geminorum disappears at 9.34 p.m. and reappears at 10.18. These are very pretty phenomena, and observers may do useful work by timing the events to the nearest second, finding the error of their watches by wireless signals.

A New Comet.

A new comet, of the twelfth magnitude, was found by Herr Reinmuth, at Konigstuhl, Heidelberg, on 22nd February; I find that it is a member of Jupiter's family, with a period of about seven years. It was nearest the sun on 1st February, being then some eighty million miles outside the earth's orbit; I was led to expect an elliptical orbit by its small inclination; very few comets moving in parabolas have small inclinations. The great comet that was seen in December has been visible again in February at the Cape and Johannesburg; these observations will permit the orbit to be accurately determined. Encke's comet was also visible in February as a fairly bright object in the evening sky; it was nearest the sun February 19.8288, which is three hours later than L. Matkiewicz's prediction. This is the thirty-seventh observed apparition of the comet.



THE FACE OF THE SKY AS SEEN FROM LONDON at 12 h. sidereal on 6th April at 11 p.m., on 21st April at 10 p.m.

A very ancient solar eclipse, observed at Ur on 23rd February, 2283 B.C., has been identified by Herr C. Schoch. Dr. Fotheringham notes that it agrees with his values of the acceleration of the sun and moon. It is about a thousand years earlier than any previously identified eclipse.

The Drayson Paradox.

There are few astronomical paradoxes that show such tenacity of life as the Drayson paradox. It had its basis in a slightly inaccurate statement in Sir John Herschel's famous work "The Outlines of Astronomy." Herschel says that the pole of the equinoctial (by which word he means the equator) describes a circle in the heavens around the pole of the ecliptic as a centre, keeping constantly at the same distance of 23° 28′ from it. It is clear that he is thinking only of the processional action of the sun and moon on the earth's equatorial protuberance, which would bring about such a circular movement. He, of course, knew of the independent movement of the ecliptic or plane of the earth's orbit, which alters both the centre and radius of this circular movement; but evidently he desired to simplify the description, though the result shows that he was unwise. The cause of the diminution of obliquity is not a mystery, but is perfectly understood by astronomers. The planets, revolving round the sun in planes slightly inclined to the ecliptic, exert a rocking action upon the ecliptic. The planes of all the planets are undergoing continual changes of this character, and so far from the change in the plane of the earth's orbit presenting any difficulty, surprise would arise if it did not take place. And yet, in the face of this exact agreement between theory and observation, Drayson propounded a view that the motion of the earth's pole was taking place not about the pole of the ecliptic, but about a point six degrees away from it. With this first error he mixed up others; he denied that the plane of the earth's orbit was changing, and he denied the reality of the proper motions of the stars, asserting that these were all due to changes in the earth's axial pose. This showed a great ignorance of the nature of the observed proper motions, for no change in the earth could cause the stars to move *inter se*; all the stars in one region of the sky would appear to move together. It is at once obvious, on examining observed proper motions, that they are not of this character, but that each star has its own motion. For example, Capella was one of the stars chosen by Drayson to illustrate his argument; but Capella is palpably moving among the more distant stars that surround it; in fact, Furuhjelm was able to pick out a distant companion of Capella by its sharing the same fairly rapid motion among the slower stars in the background. The surprising thing is that this erroneous teaching continues to attract a certain amount of support; only a few weeks ago Mr. A. H. Barley has brought out a pamphlet, which is calculated to mislead; so it is well to point out some of its errors. He makes the curiously false statement on page 6 that "no shifting of the plane of the ecliptic would alter the measure of the arc between the two poles." This shows a strange ignorance of spherical geometry; every change in the tilt of a plane involves a corres-

ponding change in its pole. He says on page 9 that the obliquity of the ecliptic will reach a minimum about A.D. 2295, or less than four centuries hence; if this were so, it is clear that the rate of diminution of obliquity would be falling off rather rapidly; actually it remains steady at about 47″ per century, as a study of the measured obliquity in different years in the Greenwich Observatory will show.

Mr. Barley falls once more into the same mistake that Mr. E. J. Stone made in 1883; the latter noticed that the errors of Hansen's tables of the moon were increasing more rapidly than astronomers had expected, and asserted that the cause was a change in the ratio of the solar to the sidereal day, brought about by the introduction of new solar tables into the Nautical Almanac. He was correct in asserting that such a change did occur, but very much in error in assigning its amount, which was only about 1/365 of the amount he gave, so that the change that he asserted to take place in a day actually took place in a year. Sir G. Airy, in a letter to the *Observatory* in May, 1883, showed the impossibility of there being such a large error in the solar day as Stone asserted.

The Recent Eclipse.

Mr. Barley also tries to make capital out of the *very small* discordances between prediction and observation in the eclipse of last June. In reality Dr. Ernest Brown is to be warmly congratulated on his success in solving the marvellously intricate problem of the moon's motion. Mr. Barley is hard put to it in trying to get evidence for the Draysonian motion of the pole from these small discordances. It is now looked upon as very highly probable that the small unexplained oscillations of the moon are due to slight variations in the rate of the earth's rotation (not affecting the direction of its axis); these might arise from some rearrangement of matter either on the earth's surface or in its interior.

In conclusion, neither Drayson nor his followers have ever attempted to give any dynamical explanation of their supposed motion of the pole. The received system is in perfect accord both with observation and dynamical theory. The ecliptic is the circle traced by the sun in its apparent annual journey, and it is also the mean position of the (slightly varying) traces of the moon; hence its pole is the natural centre for the polar motion. But what conceivable action could cause the pole to move around a point some six degrees away from this? My excuse for dealing with this paradox at such length is the persistence with which it is brought before the public, and the considerable number of people who have given in their names as its adherents. I imagine that several of them have not studied the evidence for themselves; they have been attracted by the fact that Herschel's language was undoubtedly misleading, and that Drayson gave a specious, though erroneous, argument from proper motions, and another from Ice Ages. Astronomers have never claimed to explain the Ice Ages astronomically. Any claims put forward are mere conjectures.

The photographs of Jupiter referred to in this column in February were by a slip ascribed to Professor Douglas, instead of to Dr. W. H. Wright, by whom they were taken.

Dr. John W. Evans' book, "The Determination of Minerals under the Microscope," was published by Messrs. Thomas Murby & Co. on 24th March. There are many who, knowing Dr. Evans' special knowledge of this subject, have been looking forward to the appearance of this volume. The same firm have a more elementary book on the subject on their list—"Minerals and the Microscope," by H. G. Smith—which is now widely known and used by students.

Book Reviews.

Colour-Music: The Art of Light. By A. B. Klein, M.B.E. (Crosby, Lockwood & Son. 36*s*.).

For the increasing number of students, in this country and in America, of the analogy between colour and music, and of colour harmonies, this is an epoch-making book. It may be divided into three parts—the first of which, though the least scientific, will be found perhaps of the most general interest.

In his introduction Mr. Klein describes the progress of all art from simplicity to complexity, and states that, in painting, an inter-action is beginning between science and art; he believes that the modern movement is preparing for the birth of an art of light; that is, the art of producing "colour-music" or striking harmonies and "melodies" in colour by the projection of light by mechanical means. He goes on to describe the present degradation of art in the hands of Cubists, Expressionists, etc. He thinks that painters are losing their sense of colour, whereas musicians are becoming prepossessed with it. Then comes an interesting chapter on the Psychology of Colour. The results of experiments on many American students show that colours, as regards their psychological effects, may be roughly divided into three groups, each consisting of one of the three "primaries" and the hues that adjoin it in the spectrum. Thus, the red and orange group are exciting and stimulating, the yellows and greens tranquilly cheering, the blues and violets soothing and subduing.

Mr. Klein next describes synthesia or "coloured hearing." Scriabin and Rimsky-Korsakov had mental images of colours while hearing music (the hue changing with the tonality or key—not with the note); and Scriabin devised an instrument that projected coloured lights according to the tonalities of his "Prometheus" Symphony. Mr. Klein is not inclined to see much in—nor to make much practical use of—the analogy (fascinating to minds both logical and aesthetic) between most aspects of colour, and of music. But in the second part of his book he gives a fair-minded historical survey of the analogists, beginning with Aristotle! Newton first compared the spectrum colours, and the notes of the diatonic scale, with regard, in each case, to their vibration-ratios. Chevreul, in his important work on Colour (1839) was perhaps the first to tackle the subject of colour-harmony. He noted the effects of both simultaneous and successive contrast. He also arranged the first of the many colour circles. He divides his harmonies into two species: harmonies of analogy, and of contrast; and states that, in the latter, the complementary arrangement is superior to any other—but he got his complementaries wrong. The reviewer believes that true complementaries form a harsh discord; so does Mr. Jacob, head-master of the New York Technical Art School, author of "The Art of Colour"; also Professor Rood (mentioned later in Mr. Klein's book).

Theodor Seeman, who published "The Laws of Colour-Harmony" (1891), first compared a scale of twelve hues with the twelve semi-tones of the chromatic scale. The next important writer on Colour, Professor Ogden Rood, in his "Modern Chromatics," wrote in an original manner about harmonies. He is against obtaining balance by juxtaposing hues which, if mixed, would produce a neutral grey, *i.e.*, complementaries.

The great Helmholtz, in his "Physiological Optics," mentions the colour and music comparisons. He has no great opinion of them, but recognizes that: "The saturated colours form,

really, a continuous series among themselves, if we replace by purples the void which exists between the spectrum's extremities."

Ruskin has a fine passage on the colour-harmonies found in Nature. And who (the reviewer humbly asks) would admire the rainbow were its hues not "chromatically" arranged, and were complementaries next each other?

Space forbids mention of more of the writers touched upon—except Ostwald, who in his monumental "Colour-harmonies," (1918) postulates: "Only those colours are in harmony which bear simple, definite relationship to one another." He finds, also, that this harmony depends more on their respective saturation and luminosity, than on their hues. A chapter follows giving a full account of the colour—and the colour and music analogy—but Mr. Klein finds the analogy imperfect, chiefly because the complementaries are not of *simple* ratios, as are the concords in music. But, as above stated, complementaries are *not* concords.

The last part of the book is concerned with colour-music as an independent art, and with the various instruments that have, at different times, been invented for projecting coloured light on to screens, etc. Then comes a chapter on Stage Lighting; and next, a detailed description of Professor Rimington's famous colour-organ, and other instruments; and, most ingenious of all, the author's own Colour Projector.

MARY BARNE.

Columbus—Undergraduate. By JOHN A. BENN. (London: Ernest Benn Ltd. 6s. Philadelphia: J. B. Lippincott. $2.)

(REVIEWED BY PROFESSOR ROBERT McELROY.)

This little book is intended neither as a scientific discussion of the ideal university curriculum nor as a mere tale of undergraduate adventure. It is submitted as evidence upon a very important question of international education now in the early stages of experimentation, *viz.*, the value of the system of exchange of university students between nation and nation.

In its present form, that question dates from the will of Cecil Rhodes, but George Washington, when seeking to devise ways and means to break down unreasonable prejudices which so long prevented the effective union of the American States, thus clearly stated it in his last will and testament: "It has been my ardent wish to see a plan devised on a large scale, which would have a tendency to spread systematic ideas through all parts of this rising empire, thereby to do away local attachments and State prejudices, as far as the nature of things would, or indeed ought to admit, from our national councils. Looking anxiously forward to the accomplishment of so desirable an object, . . . my mind has not been able to contemplate any plan more likely to effect the measure, than the establishment of a university . . . to which the youths of fortune and talent from all parts thereof may be sent for the completion of their education."

Washington's problem was that of destroying "local prejudices and habitual jealousies" among certain self-conscious and rather provincially-minded American Commonwealths. Cecil Rhodes envisaged the same problem from the point of view of a British Empire striving after unity. But in recent years many far-sighted men have devoted vast sums of money to the task of applying the same method to a world seeking international unity.

The interest of Mr. Benn's *Columbus—Undergraduate* lies, therefore, not so much in his educational theories, or the facts which he presents. It lies rather in the concrete evidence of what his years in Princeton did toward widening his horizon, removing unsound prejudices and making him a more tolerant and appreciative neighbour to those who dwell in lands other than his own. If his book gives evidence that this has been accomplished, it is one case in favour of the theory upon which so much wealth and intellect are to-day being generously lavished.

The first two sections are designed to show how Mr. Benn happened to make his experiment of taking a year in Princeton, before entering Cambridge. The "evidence" therefore begins with section three, "The Freshman." "Some newcomers," he remarks, "are repelled at once by the American accent, whereas, of course, it is the Englishman who has the accent when he lands in the United States." The remainder of this chapter is but an illustration of the adaptability of youth, and an illustration of the fact that the capacity to see two sides is the key to peace, at least during the trying days of Freshman year.

The engaging frankness with which Columbus confesses, on page 18, that he "secured just 12 per cent in the entrance examination in American history," and then makes three errors of fact on the same page,* does not serve to destroy the value of the chapter as an indication of changing mental outlook. What are facts among friends, and the final sentence on the page gives the evidence of growing consciousness of friendship. "The British tradition flourishes as much in Princeton as in any town in the country."

The next chapter, "Education for Everyone," is a brief, sane comparison of the aims and limitations of the American theory which has called 726,000 into higher education, with the English theory which has called only a small percentage of that number.

In Chapter V, "Earning and Learning," Mr. Benn gives, with perfect frankness, his attitude toward the man who "works his way through college," whether as waiter, laundry man, furnace tender, or shop clerk in vacation. "The whole college," he says, "is the gainer for the earnestness of men who want their education that hard," and he quotes statistics to show that, even in an expensive university like Princeton, they are gratifyingly numerous.

Of the systems of study which he considers distinctly American and distinctly English, he concludes, with perhaps an unfortunate failure to look at the "final cause," that "the former system is an advantage to the greater number, while the latter disregards the majority in favour of the few." It would perhaps be fairer to the English system which concentrates upon the few to consider whether that is necessarily a disadvantage to the many. Not a few American educators are now venturing to raise the question whether the Democracy might not be better served if the universities should eliminate a not inconsiderable percentage of their present numbers, and give the benefits of their rich endowments of equipment and able teachers to those who are best fitted by mind and temperament to profit by them.

The little chapter on "Prohibition" may serve to answer some questions, and perhaps diminish some prejudices regarding the American university and the XVIII Amendment. At any

*The College of New Jersey was not "founded by Royal Charter of George II, granted in 1748." It was founded and chartered in 1746, but a new charter was granted in 1748. "The preliminary drafting of the Declaration of Independence" did not take place in Nassau Hall; and the first President of the College did not sign the Declaration of Independence. Indeed, the first President, Dickinson, had been dead almost thirty years when the Declaration was signed. It was John Witherspoon, the sixth President, who signed the Declaration.

rate, the earnest inquirer after truth in this field can well afford to read what this English undergraduate in an American university saw, and to consider as evidence what he failed to see.

There are other features in *Columbus—Undergraduate* which deserve mention, but in the last chapter he came very near to a specific answer to the test suggested at the beginning of this review: "impressions are now so interwoven that to think separately of America is impossible." If that is the conclusion of the whole matter, it should stand as at least one clear note to encourage the generous philanthropists who are seeking to remove "local prejudices and habitual jealousies" by enabling the students of one nation to study in the universities of other nations.

In Search of our Ancestors. By MARY E. BOYLE. With a preface by the ABBÉ BREUIL. (George Harrap. 10s. 6*d*.).

"Begin at the beginning," said the king, "then go to the end and stop." This is probably the ideal way of presenting a sequence of events, but if every author had kept to this scheme there would have been no Sherlock Holmes, no Gold Bug, nor a host of other stories. The detective approaches his case with a knowledge of the facts as they stand, and it is his business to unravel the general sequence of events which gave rise to his problem. And it is in the position of a detective that Miss Boyle approaches her subject.

To a staunch evolutionist her method seems the wrong way to tell the story of primitive man; in fact, it savours of the well-known scheme of putting the cart before the horse, and yet it has its virtues. Lyell used it with great success, and he steadfastly maintained that the only way to treat geology, or, for that matter, prehistoric archaeology, was to travel from the known to the unknown, and from the familiar to the less familiar. This book is definitely intended to take the reader back through time to the very beginnings of the human race, and we travel from the Iron Age through the intervening cultures until we reach those pre-Palaeolithic mysteries, so fascinating and yet so problematical.

It is apparently not realized to any great degree how extensive the Celtic civilization really was, and how far it was influenced by those of Greece and Rome, but a fascinating picture is drawn of the northern warriors leaving their wooded homes to exchange their iron weapons for the vases and pottery of the Greeks which they prized so highly. The Bronze, Copper, and Neolithic Ages are traversed, until we reach the Palaeolithic Age, the account of which takes up half the book. The matter throughout is excellent and extremely well presented, and the large number of plates add greatly to the general interest. One could wish for more pictures of the weapons used by these long-vanished peoples, for they are all-important in chronology, but the reproductions in colour of the cave-paintings leave nothing to be desired. There are also many plates of skeletons, and of burials, together with numerous examples of sculpture. Miss Boyle says that the Magdalenians were probably unacquainted with the bow, and yet talks glibly of the paintings of arrow-heads and of carved arrow-straighteners. Again, she certainly gives the impression that in Mousterian times it was customary to knock a flake from a nodule, and subsequently to trim it on one side only, instead of chipping the block first, and detaching the worked portion by a single blow, as outlined in Professor Sollas' book "Ancient Hunters." It seems unfortunate, too, that the author has chosen that particular reproduction of Crô-Magnon man which has become known as the "professor of philosophy," and the book would have been much better had it included restorations of Mousterian man and of the earlier hominids.

The relationships of man and the Ice Age are discussed very ably, but it is doubtful if the Alpine chronology of four glaciations can be applied with any certainty to those areas directly under the influence of the Scandinavian ice sheet. Nevertheless, the suggestions that the cold Weybourn Crag may be connected with the Günz glaciation, and the Arctic plant bed with the Mindel, are both interesting, and bear some probability.

Good as Miss Boyle is as a prehistorian, her geology is not so strong, for in her concluding chapters on the earlier history of the earth there are several minor inaccuracies. It is not usual to say that the Triassic system is so-called because in Germany it is composed of an upper marl of Cretaceous age, a middle "chalk" of Jurassic age, and a lower sandstone of Triassic age. Diplodocus, we are told, used its tail and long neck to force its way through thick brushwood, and it seems as if there was a "grass-eating Dinosaur" and also a "flesh-eating species." But it is not as a geology book that we should regard this volume. It is a brave attempt to trace our ancestry back into the unknown, and it certainly gives a general view of prehistory unusually connected and complete. A preface by the Abbé Breuil insists that evolution is only a process, and although by it we are better able to appreciate the general flow of life, it affords no information on the mechanism of its working. The book possesses a time-scale which is particularly interesting in that it connects the pre-historic with the historic; a copious list of references; and a comprehensive index.

J. E. HALLIDAY

Creative Education in School, College, University, and Museum By HENRY FAIRFIELD OSBORN. (Charles Scribner's Sons.

In this work a highly-distinguished man of science, eminent as a discoverer and as one who has concerned himself greatly with the wider issues of science, summarizes "personal observation and experience of the half-century 1877-1927." Animated by a desire to tell the world the chief lessons he has learned, Professor Osborn sets out with great earnestness to propound a doctrine to which he gives the name "creative education." The reader will be eager to discover as soon as possible what meaning is to be attached to this term, what lies in it to bring new light or give him fresh guidance as student, investigator, or teacher. The reader, we are afraid, is doomed to disappointment, for creative education is, it appears, nothing but education which will be so conceived and conducted as to preserve, stimulate, and allow scope for development of the creative power and potentiality with which every human being is to some degree endowed. Creative education is, in fact, simply education of the kind which has been commended by educational prophets throughout the ages and has been practised within the limits of their ability and opportunity by every really liberal-minded teacher. It is untrammelled education. Such education surely need not or should not be called creative because it aims at making the subject creative—any more than education which helps a good inventor might be called inventive education. There seems to be a confusion of terminology. But we soon learn what is the real faith that lies behind it, and discover what it exactly is that Professor Osborn so earnestly seeks to impress upon us. What he, in fact, does in the book is to give us something like a record of his own educational beliefs and proclamations, together with an account of the

way in which he brought into existence the remarkable body of pupils who have followed his ways and risen to high distinction in the world of science. To these men the book is dedicated, and portraits of fourteen of them are interspersed in the text. We can easily understand the pride with which Professor Osborn looks upon his disciples, and the vindication they afford of the educational methods that he has propounded and followed throughout his strenuous life.

As we have already said, there is nothing in the broad educational principles advocated in this book that is likely to be challenged. As the outspoken opinions of one of the most distinguished men of science in America it has much of interest for the English reader. We have a criticism of American educational ways in schools and colleges old and new, an account of the proposed Washington-La Fayette school for boys in France, a discussion of science teaching of museums as a new force in education, excursions into philosophy, and much that is of lively interest in the occasional addresses of which the book is so largely compounded. This kind of compilation involves a good deal of re-iteration and makes somewhat restless reading, but the book has the merit of reflecting vividly the personality and ways of a man who has done great things.

A. SMITHELLS.

The Human Body. By TREVOR HEATON, M.D. (Chatto & Windus. *7s. 6d.*).

Dr. Heaton writes of the human body as a living, purposive thing, taking us from organ to organ and describing the minute complexity of their structure in terms of function and of their manifold relations with one another. He links up the slightly esoteric lore of the physiological laboratory with the common experiences of everyday life, telling us why our blood and tears are salt and why, when we warm our hands, we hold them palm-foremost to the fire, and explains many normal processes by their relation to those physiological phenomena which force themselves upon our attention when the machinery gets out of order.

Vitamins and ductless glands, which have won for themselves a certain amount of popular interest and suffered a good deal from popular misrepresentation, are plainly set forth in their true perspective, and all readers will be grateful to Dr. Heaton for his introduction to the physiological poet who has so admirably summarized the present position of endocrinology in the couplet :—

" Big glands have lesser glands to govern and unite 'em :
The scheme of their relationship extends *ad infinitum*."

The book makes no vociferous claim upon our wonder or astonishment, for Dr. Heaton writes clearly, simply, and persuasively in the best tradition of scientific literature ; but only a very dull or unimaginative reader will fail to receive an impression of rare beauty from the picture which the book slowly and patiently presents to him. The beauty is more subtle than that which strikes us from the naked and polished efficiency of the best machines, for behind those delicate and ingenious processes in the living organism that we know and understand, stretch vista after vista of other processes which are wholly or partly inexplorable and offer a continual challenge to the imagination.

The last chapter shows us disease and death from the philosophic standpoint of physiology, lifting them out of the depressing and sometimes discouraging aspect which they naturally present to the merely personal and anthropocentric point of view ; and this chapter, with the one upon the physiology of reproduction, will be a most valuable introduction to these large problems for those who are growing up and meeting them for the first time.

Dr. Heaton is to be congratulated upon the success and distinction with which he has treated probably the most difficult of all the subjects in the publisher's " Simple Guide Series."

F. A. HAMPTON.

Practical Television. By E. T. LARNER. With a Foreword by JOHN L. BAIRD. (Ernest Benn Ltd. *10s. 6d.*).

This book affords a comprehensive survey of the whole field of television. The history and development of the attempts to transmit visual objects by radio are collected and discussed with descriptions of all the principle apparatus, including, by special arrangement with the inventor, the most recent researches. There are a number of illustrations with diagrams of apparatus, and also actual photographs of transmitted pictures. The average person may, from this book, learn how to connect his existing radio set to televising apparatus, although this latter is still at a very elementary stage. With the help of Mr. Baird the whole subject is here transferred from the realm of theory into the realm of practice.

Photographic Exposure.

THERE are so few people nowadays who do not possess a camera of some sort that it is surprising that the average quality of snapshots does not reach a higher level. It might be interesting, if the task were not so stupendous, to analyse the various defects which amateur photography shows. We have no accurate data to go upon, but we suspect, from our own observations, that such analysis would reveal that a comparatively small number of failures are due to faulty selection or posing of the subject, and that an overwhelmingly large number are due to an inability to use the correct stop and to give the correct exposure. This result is surely rather remarkable, for selection of the subject is really an aesthetic matter which can hardly be governed by rules, and exposure is a question of scientific facts. There are many contrivances to enable the photographer to make the necessary calculations—contrivances which, indeed, actually provide the calculations ready made, but curiously few of them are used in proportion to the huge number of cameras in active existence. The latest piece of ingenuity in this direction which has come to our notice is the Justophot, patented by Dr. Emil Mayer, and sold by Sands, Hunter & Co., 37 Bedford Street, London, price one guinea. This little machine gives its information through actual focussing with the eye, but the focussing, it should be noted, is not of the subject itself, which is frequently a difficult thing to get into sharp outline, but of a small white numeral that appears in a dark field of vision. The instrument is so simple in its working that it can be used by the amateur who does not concern himself with anything but the extra rapid plates or films of the ordinary hand camera. It is also so complete that the skilled photographer can make adjustments to suit the requirements of any sort of special plate that he may wish to employ, and the demands of such differing subjects as interiors and snow scenes, still life and seascapes are all taken into account.

C. H.